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NOTICES

OF THE

AMERICAN MATHEMATICAL SOCIETY

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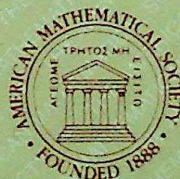
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JANUARY 1990, VOLUME 37, NUMBER 1

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Calendar of AMS Meetings and Conferences

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This calendar lists all meetings which have been approved prior to the date this issue of *Notices* was sent to the press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have been assigned. *Programs* of the meetings will appear in the issues indicated below. *First and supplementary* announcements of the meetings will have appeared in earlier issues.

Abstracts of papers presented at a meeting of the Society are published in the journal *Abstracts of papers presented to the American*

Mathematical Society in the issue corresponding to that of the *Notices* which contains the program of the meeting, insofar as is possible. Abstracts should be submitted on special forms which are available in many departments of mathematics and from the headquarters office of the Society. Abstracts of papers to be presented at the meeting must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline given below for the meeting. Note that the deadline for abstracts for consideration for presentation at special sessions is usually three weeks earlier than that specified below. For additional information, consult the meeting announcements and the list of organizers of special sessions.

Meetings

Meeting #	Date	Place	Abstract Deadline	Program Issue
855	* March 16-17, 1990	Manhattan, Kansas	Expired	February
856	* March 23-24, 1990	Fayetteville, Arkansas	Expired	February
857	* April 7-8, 1990	University Park, Pennsylvania	January 25	March
858	* April 19-22, 1990	Albuquerque, New Mexico	January 25	March
859	* August 8-11, 1990 (93rd Summer Meeting)	Columbus, Ohio	May 18	July/August
	October 20-21, 1990	Amherst, Massachusetts	August 6	October
	November 2-3, 1990	Denton, Texas	August 6	October
	January 16-19, 1991 (97th Annual Meeting)	San Francisco, California	October 10	December
	August 8-11, 1991 (94th Summer Meeting)	Orono, Maine		
	March 16-17, 1991	Southbend, Indiana		
	March 22-23, 1991	Tampa, Florida		
	January 8-11, 1992 (98th Annual Meeting)	Baltimore, Maryland		
	June 29-July 1, 1992 (Joint Meeting with the London Mathematical Society)	Cambridge, England		
	January 13-16, 1993 (99th Annual Meeting)	San Antonio, Texas		
	January 5-8, 1994 (100th Annual Meeting)	Cincinnati, Ohio		

* Please refer to page 43 for listing of special sessions.

Conferences

June 7-July 4, 1990: Joint Summer Research Conferences in the Mathematical Sciences, University of Massachusetts at Amherst, Massachusetts.

June 18-29, 1990: AMS-SIAM Summer Seminar on Vortex Dynamics and Vortex Methods, University of Washington, Seattle, Washington.

July 8-28, 1990: AMS Summer Research Institute on Differential Geometry, University of California, Los Angeles, California

Events Cosponsored by the Society

February 15-20, 1990: Section A (Mathematics) Sessions at the AAAS Annual Meeting, New Orleans, Louisiana.

Deadlines

	March Issue	April Issue	May-June Issue	July-August Issue
Classified Ads*	Feb 8, 1990	March 6, 1990	April 23, 1990	June 14, 1990
News Items	Feb 9, 1990	March 5, 1990	April 25, 1990	June 18, 1990
Meeting Announcements**	Jan 29, 1990	Feb 27, 1990	April 16, 1990	May 29, 1990

* Please contact AMS Advertising Department for an Advertising Rate Card for display advertising deadlines.

** For material to appear in the Mathematical Sciences Meetings and Conferences section.

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ARTICLES

2 Journal Price Survey - Threatened

William H. Jaco, Executive Director of the AMS, responds to a challenge to the integrity of the Journal Price Survey published in the November issue of *Notices*.

5 Encouraging Women in Math and Science

Encouraging more women to choose careers in mathematics and science is at the top of everyone's agenda these days. But how do we make it happen? Last November, about 200 mathematicians, scientists, and educators convened for a lively two-day conference to discuss various programs and studies addressing this issue. Allyn Jackson reports on this upbeat and productive conference.

FEATURE COLUMNS

7 Computers and Mathematics *Jon Barwise*

This month's column contains a piece about the computer calculus project going on at the University of Michigan at Dearborn and two reviews, one of the PC version of *Macsyma* and one on the Mac version of MathCAD.

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Edward A. Connors reports on the History of the Committee on Employment and Educational Policy (CEEP) and its Annual Survey, and William P. Thurston raises some serious questions facing the Long Range Planning Committee (LRPC) and asks for reader responses.

19 Washington Outlook

This month, Hans J. Oser examines the need for more emphasis on education from funding agencies, instructors, and textbook authors.

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Ronald L. Graham, *Special Articles*
Jeffrey C. Lagarias, *Special Articles*

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Journal Price Survey - Threatened

The ability to conduct and publish cost comparison studies of research journals is being threatened.

In 1982 the Society decided that a cost comparison study of mathematical research journals would benefit the entire mathematical community. The AMS published its first survey of American research journals in the November 1983 *Notices*. This first survey used data collected from the 1982 issues of the journals. The second survey used new data collected from the 1984 issues of the journals and was published in the March 1986 *Notices*. A companion of the second survey, a study by the European Mathematical Council (EMC) of prices of European journals, was published in the November 1986 *Notices*.

After the first survey, the AMS received notification from attorneys for Gordon & Breach, Scientific Publishers, Inc. objecting to the content of the survey as it related to the Gordon & Breach (G & B) journals. The attorneys for G & B went on to say that "... this survey may be the case of wrongful computation and may also involve trade libel of our client."

As a consequence of the EMC survey, the Chairman of the EMC was instructed by the EMC to write to those journals whose costs were significantly above average, drawing their attention to the situation and asking for their cooperation in keeping costs down. After receiving such a letter, G & B replied to the Chairman of the EMC that they believed they had "a substantial case involving trade libel" and that they had "turned this matter over to legal counsel both in the United States and in the United Kingdom."

At the height of these exchanges, the Society yielded to pressure against publishing a complete survey. The second AMS survey, appearing in the March 1986 *Notices*, did not include the G & B journals, as reported in a footnote to that survey. There was, however, no agreement to refrain from ever including G & B journals in any future survey; it would have been a disservice to our readers to have restricted the survey in such a way.

In an attempt to bring the information of the earlier surveys conducted by the AMS and published in *Notices* up to date, the AMS published, in the November 1989 *Notices*, its third survey of information taken from journal issues for the subscription years 1984, 1986 and 1988. The third AMS survey includes data on G & B journals. The data for G & B journals was collected in the same manner as that for all other journals in the survey. The AMS sent these data to all publishers with journals in the survey, including G & B, notifying them of the Society's plans to publish the data and asking for verification of the data. G & B modified and verified the data and returned it to the AMS for publication.

Since the appearance of the third AMS survey, the Society has received correspondence from attorneys representing Gordon & Breach, demanding a "retraction". Furthermore, through a statement appearing as a paid advertisement in this issue of *Notices*, G & B questions the methodology of the survey and the intent and integrity of the AMS.

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118 Shigefumi Mori Awarded 1990 Cole Prize in Algebra

The Twenty-Third Cole Prize was awarded to Shigefumi Mori of Nagoya University for his outstanding work on the classification of algebraic varieties.

120 Award for Distinguished Public Service Presented to Kenneth M. Hoffman

The 1990 AMS Award for Distinguished Public Service was presented to Kenneth M. Hoffman for his outstanding leadership in establishing channels of communication among the mathematical community, makers of public policy, and the general public.

144 Addendum to Newton's Principia, Read 300 Years Later *V. I. Arnol'd and V. A. Vasil'ev*

213 The Accidental Mathematician *Michael Albertson*

Michael Albertson shares some personal experiences and insights on Kyoto and relates them to the ICM-90 Second Announcement.

FEATURE COLUMNS

123 Computers and Mathematics *Jon Barwise*

This month's column contains reactions to the debate over proofs of program correctness; an article tracing the development of a computer environment at Lafayette College; a piece on the use of computer mail for homework assignments; and a review of True BASIC, Calculus 3.0.

132 Inside the AMS

William B. Woolf traces the evolution of the Mathematical Reviews (MR) database from paper to electronic files, and takes a glance at possible future developments.

135 Washington Outlook

This month's column, co-written by A. B. Willcox and Hans J. Oser, looks back at some of the events of the 80s and discusses the work of the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics.

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Planning

Quite a long essay could result by giving a brief description of all of the planning activities that routinely take place at the Society. The budgeting exercise has little meaning without management plans for member services, the publication program, personnel needs, capital needs, and on and on. Several management groups maintain a continuing overview of Society operations and anticipate future needs to carry on Society activities. The information gained from the work of these groups then feeds into the year-long process of arriving at expenses to carry on the Society's activities and the setting of revenues to cover expenses. The FY1991 budgeting process started in early December 1989 and will culminate in an authorized budget for Society operations for FY1991 at the conclusion of the November 1990 Board of Trustees meeting.

These are interesting processes to the members; however, they are processes that deal with the mechanisms of implementing philosophical and strategic Society planning. How are these philosophical and strategic plans formulated? There is no brief answer to this question, but there are two very important review and planning processes just beginning in the Society which illustrate the early aspects of Society planning and which point to channels by which members can voice opinions about the planning process.

First is the appropriately named Long Range Planning Committee (LRPC), a standing Committee of the Board of Trustees. While its charge can be simply stated, the scope of its charge is enormous. The LRPC is to review the functioning of the Society and to report its conclusions to the Executive Committee of the Council and to the Board of Trustees. The work of this Committee has been very influential on the policies of the Society affecting governance, development/fund raising activity, publications, management, and budget. Members of this Committee are the Chair of the Board, Treasurer, Secretary, third- and fourth-year members of the Executive Committee, and the Executive Director.

An earlier LRPC recommended that every five years the Committee become intensely active. Following this schedule, the LRPC is undertaking a serious review and planning during 1990. There is an open letter to the members of the Society from the Chair of the LRPC in the "Inside the AMS" Section of the January issue of *Notices*, page 17. This letter solicits members' ideas and responses.

The second planning process is carried out by the Executive Committee (EC) of the Council. The EC consists of the President, Secretary, the President-elect (even-numbered years) or Ex-president (odd-numbered years), and four elected members from the Council. The Council, which sets the scientific policy of the Society, has charged the EC to perform a continuing review of Society activities. This is done on a six-year cycle with three phases, each lasting two years. In these phases, the EC reviews meetings, publications, and everything other than meetings and publications. The EC is to complete the review of a phase in one year, if possible, and use the second year for study of a special topic. Presently under way is the review of publications.

For the 1990 review of publications, the EC has identified special areas of the publication program for study. Members of the EC have selected from these special areas those on which they will complete the review and report to the Council. This review process will involve other members of the Council, members of Society publication and editorial committees, AMS staff, and members at large.

Planning at the Society is a continuing activity which provides an opportunity for members to express their ideas.

William Jaco
Executive Director

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266 Graduate Education in Mathematics: *Is it Working?*

Despite the fact that mathematics education reform is being discussed in many forums—from government to business to academia—doctoral education in mathematics has largely gone unexamined. What is the mathematical sciences community saying about graduate education? Allyn Jackson's report focuses on the Joint Mathematics Meetings in Louisville in January, which provided a forum for discussion of this issue.

FEATURE COLUMNS

269 Computers and Mathematics *Jon Barwise*

This month's column contains a discussion of $\text{T}_\text{E}\text{X}$, by Michael Doob and several reviews: *SNAPPEA* by Colin Adams, *Derive* by Phil Miles, and *ISETL* by Donald Muench.

280 Inside the AMS

Frederick Gehring, chairman of the AMS Membership Committee, discusses the objectives and some of the activities of the Committee, and Herb Clemens announces the formation of the AMS Ad Hoc Committee on Cooperation with Latin American mathematicians.

282 Washington Outlook

This month, Hans J. Oser examines the 1991 Presidential budget, and how it affects Science & Technology in general & the NSF in particular.

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AMS Russian Translation Program

I would like to report on dramatic changes taking place in the Society's Russian Translation Program and, more generally, in the relationship between the Society and the Soviet mathematical and publishing communities.

The Society began its Russian Translation Program, with the aid of government grants, in 1949. The Program has been guided over the years by the Committee on Translations from Russian and Other Slavic Languages, now a joint Committee with the Institute of Mathematical Statistics, The Association for Symbolic Logic and the Society for Industrial and Applied Mathematics. By 1988, the Program had grown to include three book series, six Russian translation journals and a Russian-English Dictionary.

The Society is committed to producing high-quality, low-cost translations. The outstanding quality of our Program is recognized in both the Russian- and English-reading communities. Over the years, the Society has received requests from both communities to become more active in seeking and contracting for books and in supporting more translation journals. In 1988, the Society arranged for the consulting services of four distinguished Soviet mathematicians and hired an acquisition editor for the Russian Translation Program to identify Soviet mathematics of the very highest scientific quality.

These acquisition activities have brought exciting additions to our Russian Translation Program. We are adding two new Russian translation journals through cooperation with the Leningrad Mathematical Society, *Leningrad Mathematical Journal* and *Proceedings of the Leningrad Mathematical Society*, in addition to two new Russian translation book series, *Proceedings of Regional Conferences* and *Advances in Soviet Mathematics*. The latter is a joint venture with the Academy of Sciences of the USSR and will be published only in English. There will also be translations of several new Russian books not in series, including expository writings in mathematics to be published in cooperation with the Mathematical Association of America. The Society has co-publishing agreements with several Soviet publishing houses, and the books published under these cooperative activities will appear in the continuing series *Translations of Mathematical Monographs*. Furthermore, the long-awaited update and expansion of the *Russian-English Dictionary* (the Lohwater Dictionary) will be published this year.

Our activities have also led to changes in our interactions with the Soviets. Contractual arrangements concerning copyright have heretofore been conducted on behalf of the Soviet authors through the offices of the state copyright agency, VAAP; now, the Society negotiates directly with Soviet mathematicians (copyright contracts currently must still be countersigned by VAAP). The amount of translation now being done in the Soviet Union has increased considerably. Likewise, scientific editing will now be done in the USSR for some of the new books in the Russian Translations Program. Finally, the Society is training several Soviets for keyboarding in *AMS-T_EX* for later typesetting at the Society offices.

This account of changes in the Society's relationship with the Soviet mathematical and publishing communities would not be complete without mentioning the most dramatic change of all: the opening of the Soviet Union and the resulting personal contacts and exchanges between Soviet and Western mathematicians. The AMS is discussing cooperative activities with several Soviet mathematical societies. Soviet mathematicians have been most responsive to cooperative activities with the Society, and their support has facilitated many delicate contractual negotiations with Soviet agencies. These new exchanges have resulted in friendships with Soviet mathematicians and their families and friends. The real drama of change is with the lives of individuals.

William Jaco
Executive Director

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- 385 Rademacher on $J(\tau)$, Poincaré Series of Nonpositive Weights and the Eichler Cohomology** *Marvin I. Knopp*

Starting with the Fourier series expansion of $J(\tau)$ and specific formulas for its coefficients, Rademacher was able to prove that $J(\tau)$ is a modular invariant. Applying similar reasoning to automorphic forms of negative weight, one is naturally led to cocycle conditions and Eichler cohomology. Marvin Knopp describes the fascinating connections.

- 394 The NSF Budget Request for Fiscal Year 1991**

Fiscal year 1990 didn't bring the budget increases that NSF was hoping for, but the picture will be rosier in 1991 if the President's requested increase of 14% for fiscal 1991 actually materializes. Part of the increase will go toward starting a new batch of Science and Technology Centers and strengthening the NSF's education activities. In this annual report, Allyn Jackson examines the major components of the budget request.

- 408 Mathematics Outside of Mathematics Departments** *Solomon A. Garfunkel and Gail S. Young*

In the last twenty years, there has been a dramatic rise in the number of bachelor's degrees awarded in science and engineering. Because these areas have become increasingly mathematical, one would expect a concomitant increase in enrollments in advanced mathematics courses. But, despite large increases in calculus enrollments, enrollments in advanced mathematics have remained steady. In their study, the authors found that more students are enrolled in advanced mathematics courses outside of mathematics departments than inside them. They discuss their findings and the implications for the mathematical community.

FEATURE COLUMNS

- 417 Computers and Mathematics** *Jon Barwise*

The issue of what goes to make up good courseware for undergraduate mathematics is addressed in an article by Keith Devlin. In addition, there are reviews of several pieces of mathematical software: *FFTLIB*, *Phaser*, and three programs for the NeXT: *Groups*, *Rubik Algebra*, and *Orbit*.

- 435 Inside the AMS**

H. Hope Daly, the AMS Director of Meetings, gives a behind-the-scenes look at what it takes to put on a January Meeting.

- 438 Washington Outlook**

Hans J. Oser discusses testimony of Lauro Cavazos, Secretary of Education and Erich Bloch, Director of the National Science Foundation, given before the House Committee on Science, Space, and Technology.

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- 412 Forum** **NEW DEPARTMENT**

In this issue, the *Notices* has instituted a new department called Forum. This department, created in response to a recommendation of the AMS Science Policy Committee, will publish short articles on issues which are of interest to the mathematical community. We inaugurate the Forum with two articles concerning mathematics education and the professional mathematician.

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From the Executive Director...

Books: Acquisition and Distribution

The Society is a publisher of books. The books published by the Society are principally for the communication of research mathematics. They are published in series (Colloquium, Mathematical Surveys and Monographs ...) and out-of-series (for example, *I Have a Photographic Memory* by Halmos). The first book published by the Society was the *Proceedings of the International Mathematical Congress of 1893*. That Congress also spawned the Colloquium Series which the Society began in 1896. The Colloquium Series was the only book series for the first fifty years. Today, there are nearly thirty such series, and this year the Society has plans to publish over seventy books.

When one thinks of publishing books, one thinks of the processes of editing, composing/keyboarding, typesetting and printing. These are extremely important aspects of publishing and ones which the Society performs very well. However, there are two other important aspects of publishing that determine its content and its success in communication: acquisition of manuscripts and distribution of published materials. These are the aspects of the Society's publishing program that involve the mathematical community and depend on that community for its quality and success.

The acquisition of all Society books comes under review of editorial committees made up of volunteer research mathematicians appointed by the AMS Council. These committees respond to submitted materials by evaluating the appropriateness to the series (if it is for a book in series) and the quality of the mathematical content. However, the committees, in general, do not solicit manuscripts nor have they ever been charged with such an acquisition activity. Individuals have served as volunteer acquisition editors, but this is not the rule. At present the Society's acquisition activity is small. There has been debate in the governing bodies of the Society regarding the purpose of the Society's publication program, how it should complement publishing programs of commercial publishers and whether the Society should become more of an initiator of proposals for publication. This is not simply a matter of publishing more books, but rather of identifying, encouraging and realizing materials that will enrich the Society's efforts to communicate research mathematics. A successful acquisition program requires planning and thought about the purpose of the Society's book publication program.

The distribution of Society books has been low key. It depends to a large extent on *standing orders*, regular orders from libraries that purchase all books in given series. Yet it is responsive to the needs of the individual mathematician and provides substantial member discounts. In distribution of its books, as in acquisition, the Society has tended to respond rather than initiate. For example, one is not likely to find AMS books regularly displayed on shelves in campus bookstores. However, this is changing. The governing bodies of the Society have authorized an effort for the active distribution of AMS books to bookstores. This plan calls for the support of mathematicians, who will act as local representatives of the AMS on their campuses and as liaisons with their campus-area bookstores, and ranges from this individual activity to the establishment of a broad distribution activity. Along with this distribution effort, the Society plans to introduce a new book series that provides books usable as texts in graduate studies in mathematics.

The real news in the Society's book publishing program is happening where it has most contact with the mathematicians. By expanding our acquisition and distribution activities, we are enlarging the forum in which mathematicians can publish their work, and at the same time increasing the availability of published works to the community.

William Jaco

NOTICES

OF THE

AMERICAN MATHEMATICAL SOCIETY

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Otto Neugebauer's role in the creation and development of *Mathematical Reviews* is highlighted.

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From the Executive Director . . .

MATHEMATICS EDUCATION

As reported approximately a year ago in comments found on this page of *Notices*, new things are happening at the Society relative to mathematics education. At a recent meeting, I was involved in several discussions on "the role of the AMS in mathematics education." To put such discussions in perspective, I found it instructive to reflect on the purpose of the Society and how present issues and activities in mathematics education bear upon this purpose.

The purpose of the Society has been unchanged since its inception though the wording of that purpose has gone from "encouraging and maintaining an active interest in mathematical science" to "furtherance of the interest of mathematical scholarship and research." The latter appears in the text of incorporation of the Society in 1923 and remains as the stated purpose of the Society. How the Society carries out its activities and conducts its business within the framework of its purpose is reflected in the interpretation of that purpose by Society leadership and governing bodies. I would say the present leadership and governing bodies interpret the Society's purpose rather broadly in support of and service to the mathematical community.

The purpose of the Society and activities specific to mathematics education have been at issue before. The April 1915 Council voted that "It is deemed unwise for the American Mathematical Society to enter into the activities of the special field now covered by the *American Mathematical Monthly* . . ." What the Council of April 1915 went on to say is priceless: ". . . should an organization be formed to deal specifically with this work, the Society would entertain toward such an organization only feelings of hearty good will and encouragement." Of course, this is precisely what happened and this year we celebrate the 75th Anniversary of the Mathematical Association of America, which was founded at the meeting of the Chicago Section of the Society held in Columbus, Ohio in December 1915.

Today there is considerable public attention to issues in mathematics education from kindergarten through graduate school, and other professional mathematics organizations are working vigorously on mathematics education. But there seems to be a strong and recurring message in all of the present activity: the community commonly identified as being represented by the Society must be involved if mathematics education reform is to be complete and effective. Concern about the wisdom of the Society's entering such activities, as well as concern about the use of Society resources, continue to be raised. Compartmentalization and stratification within the community have led to issues of "turf." There will only be benefit to the community through the collective and cooperative actions of all the community; mathematics education reform and encouragement for those typically underrepresented in the study of mathematics can only be achieved through support for a strong and healthy research enterprise in mathematics; indeed, the furtherance of the interest of mathematical scholarship and research cannot be achieved without attention to issues of mathematics education.

To focus discussions of the AMS role in mathematics education and to direct Society action, the Executive Committee of the Council has recommended to the Council that a standing AMS Committee on Education be established. This Committee will provide a forum for the discussion of the full range of mathematics education issues facing the nation, including but not limited to, general mathematics education for K-12, undergraduate and graduate mathematics education, and the recruitment of young people and underrepresented groups into the profession. The Committee will recommend actions that will make a positive contribution to improving mathematics education and will communicate and coordinate these actions with the educational initiatives of other organizations.

Mathematics education involves difficult intellectual questions and is not merely a service activity. We must attempt to define and describe mathematics education in the broad professional role of the members of our community. Hopefully, we will develop a culture that will not have to ask "what is the role of a research mathematician in mathematics education?"

William Jaco

Letters to the Editor

Treatment of Book Reviews and Responses in the *Bulletin*

I am writing to express some dismay with recent actions concerning a book review written by Steven Krantz of Washington University and submitted for publication in the *Bulletin of the AMS*. As I understand events, the review by Krantz of two books by H. Peitgen, P. Richter, and D. Saupe was initially accepted for publication, edited, and galley proofs were sent to the author. Subsequently, however, the acceptance was withdrawn in response to objections to the review by Benoit Mandelbrot, and a request by him to respond in the pages of the *Bulletin*.

At Professor Krantz's request the AMS Council considered the matter. The Council voted to refer Krantz's review together with Mandelbrot's response to the *Notices* editorial committee for publication in *Notices*. An amendment to refer them instead to the *Bulletin* editorial committee for publication in the *Bulletin* was defeated. Professor Krantz declined the offer to publish in *Notices* for reasons unknown to me. Perhaps he resented the Council's implication that his review and Mandelbrot's comments, while not suitable to accompany the usual book reviews in the Society's scholarly journal, were adequate for the Society's newsletter.

On the two occasions I have been asked to write book reviews for the *Bulletin* I never dreamed that had my opinions been controversial, my reviews could have been rejected or relegated to *Notices* on that basis. By the same token, had I ever taken serious exception to a review to be published in the *Bulletin* and asked to respond to it, I would have been

astonished (as Mandelbrot probably was) if the result was the suppression of both the review and the response (or an attempt to dispose of them in *Notices*). As long as I perceive this to be the editorial policy of the *Bulletin*, I cannot in good conscience agree to review for that journal.

The correct action to have taken seems obvious to me. Both the Krantz review and a review by Mandelbrot of the same books should have been published in the same issue of the *Bulletin*. Surely, this kind of competition of ideas is the very foundation of our intellectual tradition. Controversy in mathematics may be rarer than in other disciplines, but it should be dealt with in a free market of ideas; it should not be shoved under the rug by relegating it to *Notices*.

Fortunately, both the original review of Krantz, and a response by Mandelbrot have appeared in the fall issue of the *Mathematical Intelligencer*. I urge all members of the AMS to read them both.

John Franks

Northwestern University

(Received September 14, 1989)

Boycotting Scientific Visits to China

Last week I received a letter from Professors Fuchs and Wu, asking me to join them in expressing outrage at the repressive measures taken by the Chinese government against its students and citizens. I agree 100% with Professors Fuchs and Wu that mathematicians who have interacted professionally with Chinese colleagues should speak out to condemn the brutal suppression of human rights in China. However, their letter proposed something more, i.e. a boycott of further visits to China at this time. I felt less sure whether that action was correct. Being uncertain how to respond, I put their letter on our department bulletin board, and invited faculty and graduate students in my

department to share their views on this matter with me.

The responses from our Chinese graduate students were consistent. They all said roughly the same thing, i.e. "do not reject Chinese mathematicians in this way." They told me that most Chinese students are not lucky enough to be able to study abroad; that many Chinese universities do not have enough money to subscribe to current journals; that Chinese students and scholars have great difficulties in simply learning about new developments in mathematics; that if American mathematicians reject opportunities to visit Chinese universities and institutes, some math graduate students will

Policy on Letters to the Editor

Letters submitted for publication in *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule normally requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of *Notices* in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in *Bulletin of the American Mathematical Society* will be considered for publication. All published letters must include the name of the author.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, and will be acknowledged on receipt.

lose their only contact with modern mathematics; that, while a boycott is well-intentioned, it ends up hurting the very individuals it was intended to help.

A boycott is a clear way to "do something", but on the balance I think it's wrong. Here are some alternatives. Mathematicians who are invited for future professional visits can be alert to possible opportunities to speak up. They should certainly take care to be sure they are not used to give legitimacy to a repressive regime. The AMS has a Human Rights Committee, and with enough support and input from the membership it can be an effective committee. Specific individual cases of mathematicians who have suffered from recent events must be brought to its

attention. That committee ought to be pressed if it fails to express itself appropriately. I feel that it is important that we show the world that we are a professional community with a conscience.

Joan S. Birman
Columbia University
(Received October 2, 1989)

EDITOR'S NOTE: The chair of the AMS Committee on Human Rights of Mathematicians is Alice T. Schafer. Her address is Department of Mathematics, Wellesley College, Box 64, Wellesley, MA 02181.

Support for Romanian Mathematicians

For the last six years, only one member of the Department of Mathematics of INCREST was allowed to travel to a western country to attend scientific meetings. During this period I lost more than ten such events and one may estimate the level of this loss for the more than seventy members of our Department.

I protest against this situation which affects profoundly our research! As a member of the AMS, I ask the mathematical community for support and for the promotion of scientific activity.

Dan Tiba
INCREST
Bucharest, Romania
(Received August 28, 1989)

The Collected Papers of R. H. BING

Sukhjit Singh, Steve Armentrout, Robert J. Daverman, Editors

A powerful mathematician and a great problem solver, R. H. Bing laid the foundation for a number of areas of topology. Many of his papers have continued to serve as a source of major theoretical developments and concrete applications in recent years. One outstanding example was Michael H. Freedman's use of Bing's Shrinking Criterion to solve the four-dimensional Poincaré Conjecture.

This two-volume set brings together over one hundred of Bing's research, expository, and miscellaneous papers. These works range over a great variety of topics in topology, including the topology of manifolds, decomposition spaces, continua, metrization, general topology, and geometric topology. In addition, there are a number of papers in the areas of convex functions, linearity, and conformal varieties. The introductory section in the first volume provides

historical background on Bing's life and achievements.

This collection will appeal to mathematicians in all areas, and especially those in topology, as well as students, historians, and educators in the mathematical sciences, for it provides a complete historical summary of the mathematical events in the life of the man and the mathematician, R. H. Bing.

Contents:

I. R. H. Bing: An introduction; An editorial preface; R. H. Bing: A study of his life, by S. Singh; A chronology of R. H. Bing; Ph.D. students of R. H. Bing; R. H. Bing: October 20, 1914–April 28, 1986, by R. D. Anderson and C. E. Burgess; Abstracts by R. H. Bing; II. Papers of R. H. Bing; III. Classifications of works of R. H. Bing; Publications of R. H. Bing: Classified by the year; Publications of R. H. Bing: Classified by subject matter; Works not included in these volumes; Permissions.

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Encouraging Women in Math and Science

Conference Focuses on What Causes Problems And What Makes a Difference

How do we encourage more women to pursue careers in mathematics, science, and engineering? At scientific conferences these days, there's hardly a committee meeting or keynote address that doesn't raise this question. In the past, the issue was usually raised with a lot of self-righteous pats on the back for even considering it, but nowadays, amid alarming statistics about a serious future shortfall in scientific personnel, policymakers in the various scientific communities are forced to give it serious consideration.

And now that people are abandoning simplistic explanations that boys are just plain better at math and science than girls, they are beginning to see how complicated the entire issue is. Women are sometimes seen as a homogeneous pool that can simply be siphoned off into the math and science pipeline, but the reality is much more complex. Just how complex was demonstrated at the Conference on Women in Mathematics and the Sciences, held November 10-11, 1989 at St. Cloud State University in St. Cloud, Minnesota. The conference also showed the widespread interest in this issue; the main conference organizer, Sandra Keith, a mathematician at St. Cloud, says that what began as a conference for 60-80 regional participants grew to almost 200 participants from 32 states. She also received 800-1000 inquiries from the U.S. and abroad.

If the conference established anything, it was that these problems are neither simply defined nor simply solved. Societal expectations, cultural attitudes, peer pressure, standardized testing, educational practices, toys and play experiences, competition—these are the kinds of factors that conference participants pointed to as affecting women's participation and achievement in mathematics and science. The effective programs participants described seem to share some common features, among them encouragement, peer group support, role models, and cooperative learning. There was also an emphasis on directing particular efforts toward women; high-quality educational experiences will stimulate the interest of all students, but females, more often than males, need direct, personal encouragement.

Peer group support and personal encouragement are not the kind of well-defined variables that most scientists and mathematicians feel comfortable dealing with. Indeed, at recent meetings of various policy groups in the mathematical sciences, discussions of recruiting more women are markedly different than at the St. Cloud conference. Usually the focus is on the quantitative aspect of the problem: there won't be enough white males to meet the science and technology needs of the next century. At the St. Cloud conference, this argument was rarely mentioned; the emphasis was on such issues as equity, cultural biases, encouragement, perseverance, coordinating career and family life, and communicating the excitement of scientific careers.

But this doesn't mean the discussion meandered into a fog of psychological talk. For the most part, the conference participants were chemists, physicists, biologists, and mathematicians, and they kept the discussion concrete. They understand what helped them to persevere and succeed, and now they are applying this knowledge to help other women. It was clear that the participants not only found the conference useful and interesting, but also enjoyed finding themselves at a scientific conference filled with other women.

"I felt that the attitude was celebratory, there was a very happy feeling among the participants that, finally, the contribution of women is acknowledged," says Keith. "This acknowledgment is due to changing times, changing demographics, and a recognition that women do make good students and scientists. But there's still work to be done." It would have been easy for the participants—the great majority of whom were women—to spend time exchanging complaints and horror stories, but this didn't happen. The emphasis was on success and how to make it happen.

For example, Martha Nesbitt, a Ph.D. candidate in dynamical systems from the University of Colorado at Boulder, described some of her experiences in organizing graduate students to make the department more responsive to the students. About five years ago, women graduate students organized and ran what they called

"slow pitch" colloquia, in which faculty and students would speak on various topics at such a level that any first year graduate would be able to follow the entire lecture. The colloquia have proven successful in establishing camaraderie among the students, and the quality of the lectures is such that many faculty are now attending the lectures—they enjoy the break from the "high-powered, macho" stuff of their research, Nesbitt joked.

In addition, the graduate students collaborated with the faculty to rework the first two years of graduate study to de-emphasize the preliminary examination and emphasize classes and hooking up with an advisor. Many women students were involved in these efforts and in working with faculty to insure that student concerns were heard. For example, one woman student was doing well in her classes, but had trouble passing the prelim because of time pressure. The students negotiated with faculty to give her extra time, and she passed the exam. Nesbitt said that she felt women needed to have a system that was flexible enough to change for their needs or they would quit. "Here, women felt they could change things," she said. "It's the small battles that discourage women, but, if the battles are won, that's what encourages women to keep at it."

There were a number of presentations focusing on psychological research on gender differences in mathematics and science ability. Beverly Gimmestad from the mathematics department at St. Cloud said that boys generally do better than girls on tests of visual and spatial ability. But she has found that when such skills are taught to girls, their performance is equal to the boys', implying that such skills are learned, rather than biological. Keynote speaker Marsha Matyas, a biologist who heads the Women in Science project at the American Association for the Advancement of Science, said she has found little evidence for a biological difference in male and female mathematics and science performance, but that differences emerge as a result of such factors as different play experiences and parental expectations.

Matyas also presented data from a study showing that female students have significantly less experience with scientific instruments such as barometers and telescopes, even though they indicate interest in using such equipment. She noted that boys more often than girls read science books or magazines, attend science lectures, and talk about science with their friends. In addition, social pressures often affect girls more than boys. Harvey Keynes, a mathematician at the University of Minnesota who runs a program for mathematically talented youth, says he believes that girls are socially attuned earlier than boys and are thus more vulnerable to social pressures telling them that science and mathematics are "nerdy," weird, or boring. And anyone who doubts that kids have this view of science should see the kids' drawings of the

"typical scientist" that Matyas showed—they depicted a man in a white coat performing diabolical experiments, torturing animals, or working for the FBI.

There were several presentations on successful programs for encouraging girls and women in science and mathematics. These ranged from a program in the chemistry department at the University of Alberta in which female high school students assist in research with faculty for six weeks during the summer, to a program at Rutgers University with an all-woman, math-science dormitory with about 100 undergraduates and 10 graduate students, to a 2-day conference at Argonne National Laboratory on "Science Careers in Search of Women." The programs share the common themes of specifically targeting women and providing encouragement in the form of peer group support and role models.

There was also a session on curriculum and courses, and several innovative approaches were described. Claudia Henrion, a mathematician at Middlebury College, is teaching a history of mathematics course that looks at the social and cultural factors that have influenced mathematics and that continue to influence it today. The course examines the different groups that have supported and practiced mathematics throughout its history and how they have influenced research. Anita Solow, a mathematician at Grinnell College, described her course on "Feminist History and Critiques of Science," which examines feminist perspectives on the influence of gender on science. Solow says she believes that scientists often withdraw from debate on the feminist critiques because they feel attacked, but that there is much that is valid and useful in the critiques.

The St. Cloud conference was impressive in the wide variety of topics it covered. However, the fact that the conference swelled to beyond the organizers' original plans meant that there were often three or four parallel sessions running. The conference proceedings, which are scheduled to appear in the fall of this year, will help to make more of the information accessible. Keith says she thinks the proceedings will be very useful, even for people who wouldn't ordinarily consider attending such a conference. "When people see the program, and see how many really concrete topics were covered, they may change their minds, and say, some really good stuff did happen here," she remarks. "Some people think we're drum beating, or it's a tea party, or some kind of little ladies' klatch, but it's much more serious than that."

Allyn Jackson
Staff Writer

For information on obtaining the proceedings, write to: Sandra Keith, Department of Mathematics and Statistics, St. Cloud State University, 720 South 4th Avenue, St. Cloud, MN 56301-4498.

Computers and Mathematics

Edited by Jon Barwise

Editorial notes

Computers and visual representations in mathematics

Over the past eighteen months several ways in which computers are changing mathematics have been discussed in these pages: computer assisted proofs and proof checking, mathematical writing and typesetting, experimentation in mathematical discovery, and mathematical education and communication. This month I would like to suggest another possibility.¹

Probably the greatest discrepancy between today's computers and mathematical models of them (Turing machines, say) lies in the graphical interface of the modern computer. The graphical capability of today's computer gives us powerful new tools for concretely visualizing mathematical phenomena and structures, as witnessed by programs like *Mathematica*. It is this power as much as any other which has led to their use as tools in mathematical discovery and pedagogy.

Why shouldn't this graphical capability be exploited even further? In particular, why shouldn't graphical representations share the role in mathematical proofs traditionally reserved for linguistic representations (i.e., sentences)? More specifically, why shouldn't diagrams and other forms of graphical representations be used as essential constituents in the statement of a theorem, or in its proof, or both?

This is a logical heresy, of course, as we are all taught at our mother's knee when we study geometry. But *why* should the linguistic representations have such an exclusive hold over other ways of representing mathematical objects and mathematical information? In the past, it was thought that there were hazards associated with visual representations, hazards which make them "dangerous" if used for more than heuristic aids. But upon examination one finds that all the hazards associated with visual representation are also present in linguistic representations. And the computer is beginning to provide us with tools to overcome the problems that have given diagrams and other visual representations such a bad name in mathematics. For example, there is no principled reason why an automated proof checker couldn't check a proof using diagrams.²

¹The main thought in this editorial is taken from a joint paper I have written with John Etchemendy, "Visual information and valid reasoning," to appear in an MAA volume *Visualization in Mathematics* being organized by Walter Zimmerman and Steve Cunningham.

²Indeed, we are developing a program we call *Hyperproof* to do just that in one simple domain.

This is not the place to go into these claims in detail, but I would like to give one nice example, borrowed from Colin Adams, a topologist at Williams College who is part of the geometry supercomputer project and who is interested in knots and the attempt to find mathematical invariants for them. Given a particular knot K in the 3-sphere, it is often possible to "mutate" K to obtain a new knot K' , one that is very difficult to distinguish from K . In particular, the usual invariants (such as the Alexander polynomial and the more recent two-variable polynomials) fail to distinguish the knots. Moreover, if K is hyperbolic (as the vast majority of knots are), other well-known invariants (such as the hyperbolic volume, cusp volume, conformal cusp invariant, and the Chern-Simons invariant) also fail to distinguish the knots. However, the two knots can often be distinguished by means of certain diagrams, namely horoball diagrams.³ The horoball diagram can be easily computed and graphically displayed. The result is a set of circles of varying radii in the plane. Indeed, Adams showed them to me on the Macintosh in his office last month using Jeff Weeks' Hyperbolic 3-manifold program SNAPPEA.⁴ If the horoball diagrams for the two knots differ, the knots must be distinct. (It is not known if the converse is true, though it is in the wide number of cases that have been computed.) Furthermore, the relative positioning and sizes of the circles yields much geometric and topological information about the knots. But encoding the picture in some way as a set of numbers or equations would make it extremely difficult to extract that information.⁵

The graphical potential of the computer has led Etchemendy and I, and no doubt others as well, to question the linguistic bias of modern mathematics. We suggest that horoball diagrams and other forms of visual representations may, in the not too distant future, come to share a more equal footing with the linguistic form of representing mathematical information now used for (officially) stating and proving mathematical results. Why should those mathematicians who reason and discover in private using visual representations always have to try to describe

³Adams: "The horoball diagram of a knot is a two-dimensional projection of the horoball packing in hyperbolic 3-space corresponding to the lift of a maximal cusp in the knot complement."

⁴Adams will be reviewing this program in this column in the near future. I suspect his review will contain a picture of some knots and their horoball diagrams.

⁵Reference: C. Adams, M. Hildebrand, J. Weeks, "Hyperbolic Invariants of Knots and Links", Geometry Supercomputer Project Research Report GCG 3, to appear in *Trans. of A.M.S.*

their work using solely linguistic representations, only to have the reader have to decode the result to rediscover the visual representations which led to the discovery in the first place? It is just not true that you can't have a correct proof with a diagram as an essential step. And why should we continue to be hampered by the static nature of the written word when representing dynamic phenomena, or even when presenting a dynamic proof of a static result?

If these speculations are on target, then the graphical interface of the modern computer will radically change the exposition of mathematics in the not too distant future, and force us to rethink the standard logocentric account of the logical underpinnings of our subject.

This month's column

Most of this month's column is devoted to reviews of symbolic mathematics programs in their personal computer incarnations. There is a detailed review of the PC version of Macsyma. And there is an expression of frustration in a short review of the Mac version of MathCAD. In addition, we have the following letter about MATCALC, and a piece about the computer calculus project going on at the University of Michigan at Dearborn.

A letter about MATCALC

The following letter was received from one of the developers of MATCALC.

In the "Computers and Mathematics" section of the July/August issue of *Notices*, a review appeared of the MATCALC matrix analysis package.

This package was developed by Michael Gerberg and myself in the School of Mathematics, University of New South Wales. We would like to bring it to the attention of your readers that this package has been placed in the Public Domain. At the present time, the source code (in C) and the manual (in T_EX) are available on netlib in Australia. Also, Australian netlib has forwarded the codes to Argonne for possible inclusion of the package in the US netlib network. Finally, we would like to point out that the package is not restricted to MS-DOS, UNIX and VAX/VMS operating systems, as it should run on any computer which supports the C language.

Yours sincerely,

Elvin J. Moore

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Computers-in-Calculus The Dearborn Project

David A. James

The University of Michigan - Dearborn

A major obstacle, perhaps *the* major obstacle to using computers in teaching Calculus is not the lack of demonstrable value, but the difficulty and time involved by the teacher in preparing an effective presentation. To implement computers in Calculus courses at the present time requires three things, according to Professor Karian of Denison University: some hardware, some software, and "a damned fool", which he, along with a couple hundred other of us, cheerfully admits to being. Even with a large investment of time and effort by a faculty member, much of what is tried the first time will of course not be as effective as anticipated. As Will Rogers once remarked "You can be on the right track and still get run over!" The invitation at the end of this article offers one possible solution to the Will Rogers problem.

Project Description at the University of Michigan - Dearborn

The Computers-in-Calculus project running at The University of Michigan - Dearborn uses materials developed by Professor Margret Höft and the author. The first year and a half of our four year development program has concentrated on first semester Calculus, and has been supported solely by local funding; however, we shall soon be installing new computers jointly funded by our University and NSF to continue our project.

The project involved the computer in three ways: classroom demonstrations, weekly laboratories, and homework assignments. Last year, six sections of Calculus I were taught as computer sections by the directors and one other faculty member, and fifteen sections were not. In the computer sections, three of the four meetings each week were ordinary lectures augmented by short computer demonstrations. The fourth period of the week consisted of an abbreviated lecture followed by interactive computer laboratory activities, held in a room equipped with 17 microcomputers. The three professors involved found the computer materials surprisingly successful and beneficial, and the students felt likewise (see the Survey Results section below.)

Classroom Demonstrations

Of all the uses of computers in Calculus, the most surprisingly successful for us in terms of beneficial effect per minute spent was the adding of short (3-5 minute) computer demonstrations once or twice during

regular classroom lectures. Lecturing still remains very much the center of the classroom presentation, but we found that a couple of short demonstrations on the computer every period makes a substantial difference in the level of understanding by the students, especially on topics for which a changing picture or a careful graph makes a point more clearly and convincingly than a hand-drawn static blackboard drawing. Some topics (like graphing) are simply more convincing to students if produced on the computer; others (like what it means to double and redouble the number of inscribed rectangles under a function and add their areas) become clearer when a sequence of pictures and associated sums are presented in quick succession. Students seem to concentrate exceptionally hard on these computer presentations, and this concentration often leads to greatly increased student participation in class, promoting valuable discussion and questioning of the "but what if ..." type.

We have developed effective short classroom demonstrations on about 35 topics in first and second semester Calculus. As one example, there is a program which draws the graph of $f(x)$ on the screen, then asks the user to draw $f'(x)$ using the cursor or mouse and gives the person a grade on their attempt (like 85%). This activity is extremely effective in getting students to think about the geometric relationship between $f(x)$ and $f'(x)$. Similar quizzes are presented for $f''(x)$, and it is not long before some students are better than the teachers in graphing f'' from f . As another example, within 4 minutes, students can be convinced of the existence of a continuous nowhere differentiable function, by seeing smaller and smaller sawtooth functions added to one another, and looking at the graph of the result.

Laboratory Sessions

In the once-per-week computer laboratory session, the instructor gives an abbreviated 20-minute lecture at the beginning introducing the topic of the day, and then the students are given a written 4-5 page set of laboratory instructions. Students form teams of two (we were surprised to learn that pairs learn more actively than singletons) and work through the handout under the guidance of their instructor and an undergraduate lab assistant (paid \$250 per semester through fees the students pay the university for general computer services.) The laboratory activities are interactive, requiring continual input from the students in order to proceed. Topics include how to find the slope of a curve, linear and quadratic approximation, extrema of a function, Newton's method, the definite integral, a demonstration of the Fundamental Theorem of Calculus, etc. Discussion, interaction, and comparison of results between teams is encouraged. Students fill in answers to various questions

on their handouts, attach the printouts of graphs which helped them determine their answers, complete computer homework problems found at the end of each lab handout, and try to solve a particularly thought-provoking "challenge" problem. To increase the students' written communication skills, the report must also contain a short paragraph discussing the central concepts covered in the lab. The lab reports are quite easy for the student assistant to grade, and do count toward the course grade.

Software

The software for the project was chosen with the novice user in mind. Our requirements were: 1) the student should need no previous computer experience, 2) one package should be a strong Calculus *tool*, and one package should be in the form of a *tutorial*, and 3) the student should need to invest very little time mastering a software-specific syntax. To find the best software, we held telephone interviews with faculty members at sixty colleges and universities, and then performed an extensive review of the thirty pieces of software most recommended in those interviews. For first semester Calculus using IBM PCs, we begin with *Exploring Calculus on the IBM PC* by Fraleigh/Pakula for both the classroom demonstrations and for the laboratories. This software together with our written laboratory handouts form the tutorial portion of the materials. By the fourth week we begin shifting to the more powerful *Microcalc* by Harley Flanders (our choice for the Calculus tool.) In *Microcalc*, differentiation can be carried out symbolically as well as numerically and geometrically, but for integration, the symbolic approach is not yet included, at least not until version 5.0. Both these software packages have worked out very well, although we incorporated some additions and alterations into the *Exploring Calculus* software. Playing a smaller role in our project is *CalcLab I* by Peterson for outside class drill. Finally our software choice to provide symbolic integration, other symbolic manipulations, reliable 3D graphing, and much more, is the excellent *Mathematica* by Wolfram, for which we are writing materials for three additional labs. The expense of *Mathematica* (\$10,000 for only 16 copies, as opposed to *Microcalc's* site license for \$425) has up to this time prevented us from implementing these three labs; however past experience suggests that either *Mathematica* will soon offer an affordable site license for colleges and universities, or the marketplace will produce a similar product that is affordable. The cost of purchasing all our site licenses (exclusive of *Mathematica*) totalled about \$1200 in one time costs.

Hardware

In the 1988-1989 school year, our laboratory consisted of very old ICM PCs (called "dinosaurs" by our students); for classroom demonstrations we had a single IBM clone with a hard drive, which was connected to a Telex Magnabyte LCD projection device. A recent NSF matching funds Equipment Grant will provide 17 new laboratory computers (Macintosh IIcx) and 8 Imagewriter printers for a 32-student lab, and we are currently trying to raise funds for another such room. In addition to the classroom above, we shall place a IIcx in yet another classroom for classroom demonstration purposes. These three rooms can, when properly scheduled, serve the lab and classroom needs of up to 24 daytime sections of Calculus, plus several more at night, while still leaving many hours open for free student use. It is important that the classroom computer/projection assembly be a fast machine with a hard drive in a security cabinet, ready to operate with the flick of a single switch. Two more IIcx's will be in the Department for easy access by faculty.

Is There Enough Class Time?

First, is there enough class time for the classroom demonstrations? The answer is easy: *demonstrations actually save considerable time*, whether by demonstrating concepts so memorably that repetition is not necessary, or by quickly graphing functions, or by speeding through computational bottlenecks. Newton's method can be taught in 5-10 minutes (including both the geometric underpinning and numerical examples) instead of 15-30 minutes or longer, and we found that seeing the geometry displayed so clearly, repeated for progressively quirkier functions, makes the algorithm stick in the students' mind far better than any blackboard presentation could. As another example, the delta-epsilon graphical computer tutorial and quiz is by far the best way we have ever seen to very quickly get students to intuitively comprehend the relationship which delta has to epsilon. Likewise we strongly believe that students who see both the written proof and a dynamic geometric demonstration of the Fundamental Theorem of Calculus will remember this theorem better and longer than students who see only the proof and some blackboard drawings.

The question of whether to use the computer on a particular topic is at least partly answered for us by our Rule of Conservative Computer Use (see box). We apply this touchstone to all our classroom demonstrations, laboratory handouts, and homework problems.

Use of the three Rules forces each of us who use the computer to formulate very specific and clear answers to the important question, "why use computers?" Obviously many Calculus topics do not particularly profit from use

of the computer, and the Rule of Conservative Computer Use dictates not using the computer on such topics. However, even if a teacher uses only two computer demonstrations per week, saving ten minutes each time, that still amounts to a savings of five hours over a fifteen week semester.

Laws for Use of Computers in Education (Adapted from Asimov's Laws of Robots)

- Rule 1) Computers must not be used in a way injurious to the learning process of humans (for example, must not shortcircuit human thinking and analysis by providing premature "answers".)
- Rule 2) Computers should be able to provide all reasonable information the human requests, except when such information would conflict with Rule 1.
- Rule 3) (Rule of Conservative Computer Use in Education) Computers should not be used on any topic unless the result is a genuine pedagogical improvement.

Second, what about the lecturing time lost to the computer labs? In first semester Calculus we have eight labs and we are writing three additional *Mathematica* labs, and each lab costs a half hour of lecture time. But of course the labs themselves cover their topics very well, enabling the teacher to spend far less time in class on these topics than usual. So for us, the lost lecturing time has not turned out to be a problem. The real extra time requirement is imposed on the *students* because each of our labs requires about one hour to complete, and after the abbreviated 15-20 minute lecture, there remains only a half hour of lab time, so students must make up the other half hour on their own time. We have been able to solve this problem easily at our University because on Tuesdays and Thursdays, classes are scheduled at 1 1/2 hour intervals instead of 1 hour, so we hold our labs on Tuesdays to allow a full hour of lab time after the abbreviated lecture. In this way many students finish their computer work in class. In general, however, there is certainly nothing wrong with letting students finish their labs at their own convenience, and for this reason we station one of the lab assistants in the general computer lab several hours each week.

Survey Results

A great deal of our effort has gone into the perfecting of the written laboratory handouts. We spent time sitting by students, taking notes on what parts of the labs were causing them trouble and needed revising. Lab assistants' suggestions were also sought out. Through this repeated revision process, the project is succeeding even better than we had expected. The professors involved found the materials to be a genuine benefit in the teaching and

learning of Calculus, and in a survey given to all students involved in April 1989, 86% of the students agreed that classroom demos were advantageous, and 78% found the labs beneficial. These numbers signify, we believe, the success of our approach. The results of the two most general questions on a recent student evaluation were:

	SA	A	N	D	SD
Using a computer in the classroom contributed to my understanding of the course material	12%	74%	10%	4%	0%
Using a computer in the laboratory contributed to my understanding of the course material	13%	65%	12%	10%	0%

SA = Strongly Agree A = Agree N = Neutral D = Disagree

SD = Strongly Disagree

An Invitation

We have developed materials for introducing computers into Calculus which are clearly successful at our University. If you are interested in trying out these packaged labs and classroom demos at your own college or university, we invite you to write us for copies of our materials: David James, Department of Mathematics and Statistics, University of Michigan-Dearborn, Dearborn, MI 48128-1491.

Reviews of Mathematical Software

Review of PC-Macsyma

Reviewed by Yvonne Nagel⁶

Macsyma was one of the first interactive Symbolic Algebra programs. It was originally developed at MIT from 1969 to 1982. Since 1982, the program has been further enhanced by the Computer Aided Mathematics Group of Symbolics, Inc. *PC-Macsyma* is the version of *Macsyma* written by Symbolics for 80386-based DOS-compatible PCs. The program requires an 80386-based PC with a math coprocessor, at least 4 MB of RAM and about 16 MB of hard disk space. It is bundled with a run-time version of Microsoft Windows which gives it a Macintosh-like interface. The installation instructions are well-documented. I was able to load and use the program in about an hour and 15 minutes. I used an

AT& T 80386-based PC, the WGS, with 4 MB of RAM, an 80 MB hard disk, and an 80387 math coprocessor.

In this review, I shall compare *PC-Macsyma* to other PC-based symbolic algebra programs such as *Mathematica* and *Maple* (on a MAC II) and *Derive* (on the same AT& T WGS). This is not intended to be a review of the other programs. I refer the reader to the excellent reviews of *Mathematica* by Eugene Herman⁷ and of several other Symbolic Algebra programs by Simon and Wilson.⁸

I shall also compare *PC-Macsyma* to an older version of *Macsyma* (version 412.61) running on a VAX 11/780 minicomputer. Several people in the Mathematics Department at the University of Wisconsin have used this version. I asked one of them, Peter Orlik, to run some of the batch files he had developed on the VAX version of *Macsyma* on *PC-Macsyma*.

User Interface

Basically, *Macsyma* uses a line editing system for interacting with users. You type in a statement such as

$y: (x+1)/(x-1);$

and *Macsyma* responds with a multiline echoing of your input as follows:

$x+1$

 $x-1$

Special characters such as π , e , i and α must be input as % pi, % e, % i, and % alpha, respectively. Other programs such as *Derive*, do allow the user to use special key combinations to input these special characters so that they appear on the screen as they should. According to the Simon and Wilson article, MathCAD and MATHSCRIBE do allow proper formatting of mathematics for screen viewing. There has been no improvement in *Macsyma* in this direction. Although such a feature would make it easier for the user to understand *Macsyma*'s responses, it would also make it more difficult for him to use batch files he may have created with older versions of *Macsyma* running on other machines. *PC-Macsyma* allows the user to save his output in T_EX format which can then be processed to produce prettier formulas. This feature is available through the windowing menu.

⁷Eugene Herman, "Mathematica - A Review", Computers and Mathematics, *Notices of the American Mathematical Society*, Vol 35 No. 7, November, 1988, pp. 1334-1344

⁸Barry Simon and Richard Wilson, "Supercomputers on the PC", Computers and Mathematics, *Notices of the American Mathematical Society*, Vol 35 No. 9, September, 1988, pp. 978-1001

⁶Yvonne Nagel manages the computers in the Mathematics Department at UW Madison. Her email address is ynagel@math.wisc.edu.

The user interface for *PC-Macsyma* is a vast improvement over the interface available on the VAX. Although the user is still obliged to use line editing for input, he can use a mouse or key combinations to access a menu of pull-down windows which can provide the command he needs. The *Macsyma* Help, Demo and Example libraries, which are extensive, are also available through menus. Unfortunately, not every *Macsyma* command is available through the pull-down windows and some of the demonstrations and examples take a lot of time to view. *Macsyma* has a very rich language for symbolic manipulation, but the new user needs a guide to explain the differences between, say, *ratsimp*, *radcan*, *scsimp*, and *xthru* (all of these are *Macsyma* commands for simplifying expressions). To save time, I found it useful to let the menus guide me to the proper *Macsyma* command and then looked up the details and examples in the manual. For each menu item, one can select **describe**, **examples**, or **demo** with the mouse and *PC-Macsyma* will then load the appropriate description, examples or demo for that command. If you are lazy, you can even choose **apply** with the mouse and the command will appear on your *Macsyma* "worksheet."

A nice feature of *PC-Macsyma*, which is not available with the older versions, is syntax checking. If you have a pair of mismatched parentheses, e.g., *PC-Macsyma* will point this out with the comment

Mismatched pair

and allow you to correct it before you hit return and have to retype the entire line. Actually, you do not have to hit return. Ending a line with a \$ or ; character is enough to tell *PC-Macsyma* to begin evaluating your expression. Editing is also aided by the ability to cut and paste lines by using the mouse and the pull-down edit menu. This works like cutting and pasting on a Macintosh.

Benchmarks

The following benchmark tests were taken from the articles by Simon and Wilson and by Eugene Herman which we mentioned earlier.

1. Roots

Find the roots of the polynomial $x^3 - x^2 - x - 1$ over the complex numbers.

```
(C1) allroots(x^3-x^2-x-1);
```

Macsyma gave the roots to five-place accuracy.

2. Factor

Factor the integer 266382004787 using the command:

```
(C2) factor(266382004787);
```

3. Integration

Find the indefinite integral $\int \frac{1+x}{1+x^2+x^4+x^6} dx$, then differentiate it and simplify the result.

```
(C1) integrate((1+x)/(1+x^2+x^4+x^6),x);
(C2) diff(%,x);
(C3) ratsimp(%)
```

4. Matrices

The Hilbert matrix is defined by

$$H_n(i, j) = \frac{1}{i+j-1} \quad \text{for } i, j = 1, \dots, n$$

This matrix is ill-conditioned for large n . The problem is to find the largest Hilbert matrix which can be inverted by the program. I used the commands

```
(C1) h[i,j] := 1/(i+j-1)$
(C2) hn:genmatrix(h,n,n);
(C3) invert(hn);
```

to create and invert the $n \times n$ Hilbert matrix. I then used $n = 5, 6, 7$

5. 3D Plot

Plot the function $\frac{x^2-y^2}{x^2+y^2}$ over the square $-1 \leq x \leq 1$ and $-1 \leq y \leq 1$. The interesting point is what *PC-Macsyma* would do about the singularity at $(0, 0)$.

```
(C4) y:(x^2-y^2)/(x^2+y^2)$
(C5) Plot3d(y,x,-1,1,y,-1,1);
```

PC-Macsyma was able to do the 3D-surface plot although the grid was coarser than the one produced by *Mathematica* for this function.

Summary

The following table summarizes the performance of the various versions of *Macsyma* we used and of *Mathematica* and *Maple* on the Macintosh and *Derive*⁹ on the AT&T WGS. All times are in the form minutes:seconds. For the Hilbert matrices on *Derive* I used the built in *Derive* timer. The times for the other tests were less precise since my timing device could not accurately measure times less than 1 second. Also, each time given below represents the time it took each program to do the computation and return a complete answer.

⁹*Derive* was included in these tests because it is a symbolic manipulation program which runs on the 80386-based PC. It is not in the same class as the other programs because it is not programmable and does not have as many capabilities. Still, it is easy to use and on the simpler benchmarks it performed as well as the others.

Test	PC-	Vax	Mathematica	Maple	Derive
	Macysma	Maxsma			
Roots	:05	:05	:04	:04	:04
Factor	1:15	:30	:01	:01	:01
Integral	1:10	:20	:05	:15	
Differentiate	:10	:07	:03	:05	
Simplify	:45	:05	:05		
Hilbert(5)	1:20	1:10	:02	:05	:00.4
Hilbert(6)	3:25	2:20	:03	:08	:00.6
Hilbert(7)	11:50	11:25	:03	:12	:00.8
3D Plot	2:10		:06.4		

Difficult Integral

I wanted to see what *PC-Macysma*, *Mathematica*, and *Maple* would do with the following integration problem taken from a standard Calculus text.¹⁰

The problem is to find the volume of the solid obtained by boring a square hole of side C through the middle of a sphere of radius B . It is problem 37 on page 936 of the Thomas and Finney text. The authors claim that *Macysma* was able to do the integral in 20 minutes.

This can be expressed as a double integral:

$$8 \int_0^C \int_0^C \sqrt{B^2 - x^2 - y^2} dx dy$$

or, if we make a change of variables to cylindrical coordinates and integrate in θ , the volume can be obtained by evaluating the single integral:

$$16B^2 - \frac{16}{3} \int_0^{\pi/4} (B^2 - C^2 \sec^2(\theta))^{3/2} d\theta$$

I tried to do the indefinite integrals corresponding to each of the definite integrals above. Here are the results:

PC-Macysma could not do the double integral, it did the second integral in 5 minutes, yielding the following result:

$$\begin{aligned} & \frac{i b^4 \left(\log \left(\frac{2|b| \sqrt{-c^2 \tan^2 \theta - c^2 + b^2}}{\sqrt{4 \tan^2 \theta + 4}} + \frac{2b^2}{\sqrt{4 \tan^2 \theta + 4}} + i c^2 \right) \right)}{2|b|} \\ & + \frac{i b^4 \left(\log \left(\frac{2|b| \sqrt{-c^2 \tan^2 \theta - c^2 + b^2}}{\sqrt{4 \tan^2 \theta + 4}} + \frac{2b^2}{\sqrt{4 \tan^2 \theta + 4}} - i c^2 \right) \right)}{2|b|} \end{aligned}$$

¹⁰Thomas, George B. and Ross L. Finney, "Calculus and Analytic Geometry, Sixth Edition", Addison-Wesley, Reading, Massachusetts, 1984.

$$\begin{aligned} & \frac{c^4 \left(\arcsin \frac{c^2 (\tan \theta)}{\sqrt{b^2 c^2 - c^4}} \right)}{2|c|} \\ & - \frac{3 b^2 c^2 \left(\arcsin \frac{c^2 (\tan \theta)}{\sqrt{b^2 c^2 - c^4}} \right)}{2|c|} \\ & - \frac{c^2 (\tan \theta) \sqrt{-c^2 \tan^2 \theta - c^2 + b^2}}{2} \end{aligned}$$

Mathematica did one of the double integrals only. It could not do the second integral. *Maple* could not do the second integral. It did the double integral yielding the following answer:

$$\begin{aligned} & -\frac{5}{12} C^3 \arcsin \left(\frac{C}{\sqrt{B^2 - C^2}} \right) + \frac{1}{3} C^2 \sqrt{B^2 - C^2} \\ & - \frac{1}{12} B^2 \arcsin \left(\frac{C}{\sqrt{B^2 - C^2}} \right) C \\ & \frac{13}{12} \arcsin \left(\frac{C}{\sqrt{B^2 - C^2}} \right) B^2 C + \frac{1}{6} \arcsin \left(\frac{B^2 - BC - C^2}{(B - C) \sqrt{B^2 - C^2}} \right) B^3 \\ & - \frac{1}{6} \arcsin \left(\frac{B^2 - BC - C^2}{(B - C) \sqrt{B^2 - C^2}} \right) B^3 \\ & \frac{C^3}{12} \arcsin \left(\frac{C}{\sqrt{B^2 - C^2}} \right) \end{aligned}$$

Compatibility

To test whether *PC-Macysma* was compatible with the VAX version, I asked Peter Orlik for some sample batch and lisp files which he had used with VAXIMA. He generously contributed these and his own time for this test. Peter had written his own *Macysma* routines to compute matrices with polynomial entries which occur in the invariant theory of certain groups. The calculations require *Macysma* to invert a matrix of polynomials and to show that this inverse when multiplied by another matrix has only polynomial entries. The difficulty lies in performing the individual polynomial divisions for the entries. One computation, for example, involved dividing a polynomial in four variables of degree 30 by a polynomial in four variables of degree 12. However, *PC-Macysma* took 7-8 minutes to do an inversion which took the VAX less than a minute. It is possible that we could have done a larger matrix if we had created a larger swap file for the program. *PC-Macysma* does seem to be compatible with the VAX version, however, since LISP files generated by it on the VAX can be run on the PC.

Conclusion

PC-Macsyma has both strengths and weaknesses. On the negative side, it was slower than any of the other programs we tested. It was only slightly slower than the VAX version and *Derive* indicating that the slowness is probably due to the program itself rather than the machine. It was considerably slower than *Mathematica*, *Maple* and *Derive* on the simplest benchmark tests.

However, this slowness must be balanced against some major strengths. Chief among these is its extensive library of well-tested routines. With one or two exceptions, *PC-Macsyma* has all the routines found in the VAX version. Therefore, it can tackle a wider range of problems than, say, *Mathematica* or *Derive*. In addition, Symbolics, Inc. has made major improvements in the user-interface to make it more competitive with more user-friendly programs. These improvements include the runtime version of Microsoft Windows, the use of the mouse and menus to make the help libraries and examples more accessible to users, the ability to save output in TeX format, and the instantaneous syntax checking. The original version of *Macsyma* already had the ability to import and export data in LISP or FORTRAN format and *PC-Macsyma* has kept this feature. In addition, *Macsyma* batch and lisp files developed on the VAX can be ported to the PC and vice-versa. This feature makes it possible to do development work on a PC and then port the files to a larger machine.

A list of all the types of problems which can be solved by *PC-Macsyma* is available from Symbolics. It contains approximately 150 items. I will list some of them below:

Algebra:

Complex Arithmetic, exact and floating point arithmetic, algebraic integer identities, continued fractions, substitution and part extraction, trigonometric and hyperbolic functions and their inverses, Poisson series, rank, determinant, inverse and triangularization of matrices, Gram-Schmidt orthogonalization, Moore-Penrose generalized inverse, orthogonal polynomials and related functions (Bessel, Neumann, Hankel, gamma, Bernoulli, zeta, Euler, Erf, Fibonacci and Airy functions)

Calculus:

Limits, Differentiation, Partial derivatives of unknown functions, Taylor and Laurent series, Pade approximants, indefinite and definite integrals, Laplace and Fourier transforms, Dirac delta functions and integrals, four methods of numerical integration, Fast Fourier transform, linear, separable and exact first order ODE's, Laplace transform method for solving ODE's, Bernoulli and Riccati equations, Prell-Singer method, initial and boundary value problems. Second order ODE's: constant

coefficient, exact, linear and homogeneous methods, variation of parameters, hypergeometric solutions, Whittaker solutions. Systems of Linear ODE's. Perturbation and Taylor Methods: Lindstedt's method, method of averaging and method of multiple scales. Numerical Solutions: Runge-Kutta for systems of ODE's, finite difference equations. Integral Equations: Abel's method, Taylor series, pseudo-Picard iteration, Taylor and Neumann series, Fredholm-Carleman series.

Vector and Tensor Analysis

Vector calculus: dot and cross products, grad, div, curl, Laplacian. Indicial Tensor Calculus: Einstein summation rules, indicial tensor assignment statements, covariant derivative and curvature, tensor symmetries and contractions. Exterior calculus of differential forms: exterior multiplication and derivative, Lie derivative, vector-form contraction.

Graphics

Two-dimensional plots: parametric plots, vector fields, adaptive density plots. Three-dimensional plots: hidden line removal, change of perspective, contour plots. Plot utilities: user controlled color graphics, changing axes and scale, coordinate transformations, user-input labels and symbols, superimposing plots, hardcopy.

Utilities

Rational function based pattern matcher, assign math properties to symbols, translation of expressions in Fortran and 'C', mix Fortran (or 'C') and *Macsyma* languages, generate TeX output.

Ordering Information

PC-MACSYMA is currently available from
SYMBOLICS, Inc.

Computer Aided Mathematics Group
8 New England Executive Park East
Burlington, MA 01803

A single copy of *PC-MACSYMA* is \$1950 (\$1250 with academic discount). Academic purchases can buy 10 copies for \$5090, which makes it more expensive than *Maple* but less expensive than *Mathematica*.

System Requirements

	Minimum Configuration	Recommended Configuration
Main memory	4 MB	6 MB
Swap Space	8 MB	10 MB
Hard Disk	30 MB	40 MB
Graphics	EGA, CGA, or VGA	EGA, CGA, or VGA
Windows	runtime version of MS-Windows	MS-WINDOWS & MS-PAINT

MathCAD for the Macintosh

Reviewed by Mary Beth Ruskai¹¹

The IBM PC version of MathCAD has been favorably reviewed in several journals, including this column (Sept., 1988), and some of my colleagues had mentioned it enthusiastically. Therefore, when MathSoft began to advertise a Macintosh version, I decided it was worth trying. Unfortunately, the Macintosh interface leaves much to be desired. As a result of my dissatisfaction, I have not used MathCAD very much. Therefore, my comments should be regarded as a warning from one frustrated user, rather than a comprehensive review.

The most serious defect is that MathCAD does *not* follow the familiar Macintosh rules for editing. As a result, using MathCAD is extremely frustrating for an experienced Macintosh user. For example, you cannot select a region by the usual method of dragging the mouse, as you would expect. Instead, depending on what you want to edit, you must click, double-click, or shift-click in an appropriate place. Once a region has been successfully selected, the rules for cutting and pasting are fairly standard. Finding the right spot to click can be a challenge, though. As the manual warns, "You can't edit an equation by clicking the insertion point on a blank spot within an equation. You must instead click somewhere on a name number, or operator. If you click on a blank spot and begin typing, MathCAD beeps and does nothing." While one could probably get used to MathCAD's editing quirks with sufficient use, they are a definite deterrent for both beginners and occasional users.

MathSoft's advertising emphasizes that equations appear in familiar (wysiwyg) mathematical notation. Although this claim is literally correct, the appearance of

the equations is awkward and well below the quality one gets in an editor like MacEqn or MathType. Exponents seem to be a full line above the baseline of the equation. In some cases, I found the result less desirable than single-line alternatives like \sqrt{x} or a/b . Nor is this entirely a matter of aesthetics; even simple equations take up a lot of space if they involve exponents, fractions, and sub or superscripts. This limits the number of equations which can fit on a single screen, a real drawback in a complicated computation. In view of the Mac's superb graphics capabilities, and the ease with which editors like MacEqn were developed, there seems to be little excuse for the poor quality.

The documentation is reasonably clear in the sense that things are easy to look up and understand in the manual. However, the introductory section could be greatly improved; at present, it does not warn the user of MathCAD's editing quirks. The advertising and accompanying materials emphasize that equations can be placed anywhere on the screen. However, this is somewhat misleading because the order in which equations appear will affect the result. For example, if you place a function definition below its graph, you will get an error message when you ask MathCAD to plot the graph; the defining "equation" must appear *above* the graph.

MathSoft recently released an upgrade to version 2.03 which remedies one of my earlier complaints. MathCAD relies on long menus, whose keyboard equivalents are obscure at best. These menus now float, i.e., you can drag them so that they remain visible while working in the MathCAD document window. There is also a version of 2.03 which supports the 6888x math coprocessor.

For those who still want to give MathCAD for the Macintosh a try, it should be noted that MathSoft (1-800-MATHCAD) offers substantial educational discounts for both single-copy and bulk orders. The system requirements are MacPlus or better (SE or MacII) and system version 6.02 or later. It needs at least one megabyte RAM and either two disk drives or a hard disk. All Mac-compatible printers are supported, including the laser-writer.

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Inside the AMS

CEEP and the Annual Survey

Edward A. Connors

Chair, AMS-MAA Committee on Employment and Educational Policy

The AMS Council and the MAA Board of Governors have agreed to the request from the AMS-MAA Committee on Employment and Educational Policy (CEEP) that its Data Subcommittee be established as a standing joint committee. This action was initiated because Data had outgrown its subcommittee "space" within CEEP, as evidenced, for example, by the preponderance of data items on each CEEP meeting agenda. Moreover, the importance of the data gathering and publishing activity justifies a separate, more visible committee. The occasion provides the opportunity to reflect on some of the history of the Committee on Employment and Educational Policy, whose existence spans the period of post-Sputnik growth in the mathematical sciences to the present time.

CEEP had its origins in the AMS Committee to Investigate Present Economic Status of Teachers (later shortened to the Committee on the Economic Status of Teachers). In August 1956 the President of the AMS was asked to appoint a committee to study the economic status of teachers, with consideration restricted to mathematicians rather than teachers in general. The Committee appointed was: George N. Garrison, Wallace Givens, and Henry M. Schaerf, with Givens as chair. Its first task was a modest salary survey, reported in the December 1957 *Notices*, which surveyed 61 departments of mathematics that had been polled in the 1955-1956 Survey of Training and Research Potential in the Mathematical Sciences (the Albert Survey). Soon thereafter the AMS Council directed the Executive Director to make "a survey of mathematicians' salaries on an annual basis and publish the results in *Notices*" (October 1958 *Notices*). It was believed that publication of salary data "would be useful in efforts to obtain satisfactory salaries for mathematicians". In 1960 the survey was expanded to include the starting salaries of new Ph.D.'s in mathematics.

The 12th Annual Survey (with data for the academic years 1967-1968 and 1968-1969) was the first to use a classification of departments by the highest degree conferred in mathematics. Moreover, the Ph.D. granting departments were separated into four classifications based on the 1964 survey conducted by the American Council of Education (October 1968 *Notices*). The 14th Annual Survey expanded the scope to include data on graduate student support and the annual projected faculty growth for a five-year period.

At the Annual Meeting in Atlantic City in January 1971, the Council of the AMS voted to expand the charge of the Committee to Advise on Analysis of Employment Data (the successor to the Committee on the Economic Status of Teachers) and rename it as the Committee on Employment and Educational Policy. The members were Richard D. Anderson, William L. Duren, Jr. (chair), John W. Jewett, and Gail S. Young. As part of the expanded charge the Committee members were granted permission by the editors of *Notices* to make editorial comments in *Notices* on the data gathered by the Committee from various sources, including the published data of the CBMS Survey Committee. The first of these comments, entitled "The Problems of Employment in Mathematical Sciences", was written by Gail Young (August 1971 *Notices*). It was the first of several such articles written by Young, Dick Anderson, John Jewett, Wendell Fleming, and others. At the 1971 summer meeting at Pennsylvania State University, CEEP held a panel discussion on the then current job market. The faculty flow analysis presented by Dick Anderson at the panel discussion was written up in summary form by Lincoln Durst, Deputy Executive Director of the AMS, and published in the October 1971 *Notices*.

CEEP continued to expand its work well beyond its Annual Survey responsibilities. The very successful Short Courses were begun as a means of retraining pure mathematicians for computer science and applied mathematics. Meetings for heads and chairs of departments of mathematical sciences were organized at the annual and summer meetings. Nonacademic salary surveys have been conducted by Bob Thompson and Arthur Mattuck

A full membership survey was conducted in 1976. Recently the new publication, *Assistantships and Graduate Fellowships* in the Mathematical Sciences, carrying information formerly published in the special December issue of *Notices*, was developed under the auspices of CEEP. In the meantime, the scope of the Annual Survey expanded to include data on enrollments, class size, faculty and graduate student size and status, faculty mobility, status of women in the faculty, and other statistics vital to the needs of the mathematical community. To the extent that it is feasible, counts are now made by sex and citizenship. A list of thesis titles of new doctorates is reported annually. In 1987 CEEP became a joint AMS-MAA committee, and the MAA now contributes financial support for the Annual Survey.

In connection with its data gathering efforts, CEEP has maintained a close working relationship with the CBMS Survey and, more recently, with the Science Resource Studies Division of the National Science Foundation. The affiliation of the AMS and MAA with the Commission on Professionals in Science and Technology (formerly the Manpower Commission) has provided a valuable link to data gatherers and analysts in our sister sciences and industry.

In the words of its former chair (Don Rung of Pennsylvania State University) CEEP has been a committee of "worker bees". Certainly the efforts of Bill Duren, Gail Young, John Jewett, Dick Anderson, Wendell Fleming, Lida Barrett, and Don Rung justify that characterization. But none has worked as hard as the dedicated members of the AMS staff in Providence: Lincoln Durst, retired Deputy Executive Director, Jim Maxwell, present Associate Executive Director, and, especially, Marcia Almeida and Monica Foulkes.

As we prepare to move into the 1990s and toward the 21st Century, it is abundantly clear that the mathematical sciences will need good, hard data to chart their course and bolster their arguments for increased support. The Data Committee will continue to work to gather, analyze and publish vital information necessary for this purpose. It is hoped that the new committee will be a clearinghouse of information on the mathematical sciences and a means of avoiding the plethora of ad hoc surveys which flow through departments at an ever-increasing rate.

Advice Sought

William P. Thurston, Chair

Long Range Planning Committee

The Long Range Planning Committee (LRPC) is a standing committee of the Board of Trustees of the Society. Briefly, the charge to the LRPC is to review the functioning of the Society and its priorities, and to

report its conclusions to the Executive Committee of the Council and the Board of Trustees. At regular intervals (every five years) the LRPC is to become intensely active.

Following this schedule, we are undertaking a serious review of the AMS during 1990. By the end of the year, we expect to have proposals enabling the Society to better meet the needs of its members and the needs of the profession. The first step is to gather information and ideas. We solicit your responses to three basic questions:

- * Does the AMS do what it does well?
- * What should the AMS be doing that it is not doing?
- * What does the AMS do that it should not be doing?

We have a number of more specific (but still wide ranging) questions that warrant serious answers. Some of them are listed below. Please write to us with your ideas on these or other issues.

Some of the questions

Are we doing what we should for mathematics education?

There has been a swell of public attention to the issue of mathematics education in kindergarten through graduate school. Some other organizations, notably the Mathematical Association of America, National Council of Teachers of Mathematics, and Mathematical Sciences Education Board, are working vigorously on mathematics education, but the AMS is relatively quiescent even on graduate and undergraduate education. Are there actions the AMS could and should take; for instance to facilitate the engagement of mathematicians in educational issues, to build channels of communication between mathematicians and high school teachers, or to recruit more young people into mathematics?

Underrepresented groups. There has been much talk about the fact that women and minorities are dramatically underrepresented in mathematics. What concrete steps can the AMS take to make a genuine improvement in this bad situation?

How well does the AMS fulfill its role as a professional organization? There are major differences between the AMS and many other professional organizations. Should we set up sections based on subfields of mathematics or various activities, such as education or computing, which might organize conferences or publish journals? Should we establish strong local or regional bases of operation? Should we get more involved in advocacy for professional standards and working conditions within colleges and universities? Should we increase or decrease our involvement in governmental and public affairs in Washington?

Can we do something to heal the compartmentalization and stratification of mathematics and mathematics education? Mathematics education in our country is handled by a vast compartmentalized and stratified

structure with little communication between the compartments. Mathematical research is also divided into compartments with less than ideal communication. The compartmentalization arises partly from different professional organizations claiming different parts of the territory. What should the AMS do?

What can we do to improve the structure and governance of the Society? Are there ways we should change the governance of the AMS? Are there structural changes which would make the Society more responsive to the needs of the mathematical community or increase the involvement of the mathematical community in initiatives of the Society?

Which directions should we pursue in publications? Most of the budget and staff activity of the AMS is in publishing. Through publication, the AMS provides an exchange of mathematical information and also generates funds that help the Society provide other services. The Society has the ability and the responsibility to publish at low prices compared to commercial publishers. We are taking steps to get our books into bookstores, and we have many opportunities for dramatic expansion of publications. In which directions should we go: graduate texts, undergraduate texts, specialty journals, more translation journals, popular books, other?

What can the AMS better do for its members? Do our meetings speak to the interests and needs of mathematicians? Are most talks either too specialized, too high-brow, or too numerous? Should we place more emphasis on professional concerns besides research? Should we invite more outsiders to speak? Should we change the content of the *Notices*, or offer other journals to members? Should we link with more local, regional or specialized meetings? Should we establish networks or consulting services on such common issues as computers, libraries, language problems, textbook selection, curricular innovations?

Addresses

Comments should be mailed to

Long Range Planning Committee, American Mathematical Society, PO Box 6248, Providence, RI 02940
or by email to LRPC@math.ams.com.

We will assume that we may, at our discretion, share your response with the Officers and Council of the AMS.

The members of the LRPC for 1990 are:

Robert M. Fossum, AMS Secretary, University of Illinois at Urbana-Champaign, robert@abel.math.uiuc.edu

Ronald L. Graham, Chair of AMS Board of Trustees, AT&T Bell Laboratories, Murray Hill, rlg@research.att.com

William H. Jaco, AMS Executive Director,
whj@math.ams.com

Franklin P. Peterson, AMS Treasurer, Massachusetts Institute of Technology

Hugo Rossi, member of AMS Executive Committee, University of Utah, ma.rossi@science.utah.edu

William P. Thurston, Chair of LRPC and member of AMS Executive Committee, Princeton University,
thurston@math.princeton.edu

(Continued from page 2)

Journal Price Survey - Threatened

Most of G & B's objections to the methodology are familiar ones and apply equally to most journals. In particular, for every journal in the survey we used the "list" price; many of these journals offer discounts from list for libraries, individuals and others. Indeed, every effort was made to make the data in the survey as complete and as accurate as possible. Publishers, including G & B, had an opportunity to correct any errors they saw. Page charges, outside support and discounting structures are all reported in the survey and indicated as variables necessary to take into account in any analysis. While membership dues conceivably could be a factor in the price of a society's journals, it is not actually a source of support for journals other than those provided as a privilege of membership. Since all journals in the survey are research level, there is no *a priori* reason that some have a restricted potential market.

There is simply no basis for the attack made by G & B on AMS. G & B are entitled, if they wish, to dispute the methodology, even though we find their arguments to be thin and self-serving. An open flow of information (and if needed an open debate) is in the best interest of all concerned. From this line of reasoning, we agreed to print the "advertisement" of G & B, even though the tone for the "advertisement" is regrettable. What G & B ought not to do, in our opinion, is to threaten the collection and dissemination of information by letters from legal counsel.

Price surveys of mathematical research journals are not the only such studies under threat. Gordon & Breach is suing the American Institute of Physics over an article and a letter about the costs of professional journals that were published in AIP's monthly magazine, *Physics Today*. Publishers must depend on clientele and it is difficult to believe that threats and actions of this kind can be other than counterproductive.

William Jaco
Executive Director

Washington Outlook

This month's column is written by Hans J. Oser, who is a consultant to the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics in Washington, D.C.

The 1990 budget has still not been enacted, even though we are, at this writing, already seven weeks into the fiscal year. The uncertainty over the final 1990 budget dominated the agenda when Erich Bloch met with the advisory panel for Mathematical Sciences Division at NSF in early November. Now that the proposed doubling of the NSF budget has been side-tracked for the third time, Bloch seems convinced that government funded R&D is in for an extended period of belt tightening. As the amounts to be saved in the deficit reduction process become larger every year, and tax increases continue to be very unlikely, Bloch feels that the years of rapid growth for the NSF research budget have probably run their course. He made it clear to the mathematics panel that the long neglect of education requires adjustments in the balance between the support for research and for education and that the pendulum had simply swung too far in the other direction.

The emphasis on higher investments in education has a strong resonance in Congress, where both the House and the Senate have held hearings on the issue of mathematics and science education. We have reported on the hearings by the House Committee on Science, Space, and Technology which continued throughout spring and summer. On 14 November, Senator Kennedy's Committee on Labor and Human Resources held hearings on "The Crisis in American Math, Science, and Engineering Education". Besides presenting the usual statistics on the poor performance of our high school students in international science and math competitions, the witnesses were quite blunt in their calls for a national set of standards to which the 11,000 school districts should

address themselves. They deplored the textbook situation and the inadequacy of teacher training. To make science attractive to the K-12 age group, they also called for better equipment, more demonstrations and less textbook learning. Rather than seeing students with increased curiosity about nature as they advance to secondary school, the witnesses found the students' lack of comprehension about our environment rather appalling. For example, less than half of our college graduates are able to explain why the summers are hot and the winters are cold, the majority of them believing that it has to do with the distance of the earth from the sun.

Better textbooks and better teacher training are desperately needed, especially in view of the demographic fact that from now until 1995 only 15% of the net increase in the workforce will be white males, traditionally the large majority of the workforce. We must prepare women and minorities for professional careers in science, technology and mathematics. It is no secret that we are not doing it well now.

From time to time, the NSF director issues so-called Important Notices to presidents of colleges and universities and other grantees. Two of these were issued in 1989 that deserve attention because they signal departures from past policy and practice. The first, IN-106, was issued in April 1989 and deals with the openness of scientific communication with respect to the timeliness of publication and to authorship accurately reflecting the contributions of those involved. The notice also recommends that universities develop policies and guidelines to deal with alleged incidents of fraud and misconduct.

The second notice, IN-107, published in September, reflects the new NSF emphasis on education and human resources (see *Notices*, October 1989, page 1003).

The Joint Policy Board for Mathematics welcomes comments about Washington Outlook. You can reach us over the Internet communications network under the address: jpbm@athena.umd.edu

News and Announcements

Louise Hay 1935-1989

Louise Hay, Head of the Department of Mathematics, Statistics, and Computer Science at the University of Illinois at Chicago, died October 28, 1989 of cancer. She became in 1980 the only female head of a major research-oriented university mathematics department in the United States. She had a world-wide reputation in mathematical logic and theoretical computer science.

Born as Louise Schmir, to Polish emigres in Metz, France, she spent some time as a refugee in Switzerland before emigrating to New York in 1946. Her 1952 project on non-Euclidean geometries was a winning entry in the Westinghouse Talent Search. She graduated from Swarthmore College in 1956 and received an M.A. (1959) and Ph.D. (1965) from Cornell. She was a Post-Doctoral Fellow at M.I.T. in 1966-1967. After several years at Mt. Holyoke College she joined the University of Illinois at Chicago Circle in 1968. Her later visiting positions included a Fulbright in the Philipines.

Hay worked primarily in recursion theory and theoretical computer science. Her thesis represented a substantial advance in the Dekker-Myhill-Nerode theory of recursive equivalence types and isols. She classified the index sets of finite classes of r.e. (recursively enumerable) sets and studied the difference hierarchy on r.e. sets. With Douglas Miller, she developed a topological analog

of the theory of index sets. During the 1980s her interests turned to complexity theory. She studied the class of predicates which are truth table reducible to predicates calculable in nondeterministic polynomial time and reducibilities that allow only a bounded number of queries. In still other directions, she authored with A.O.L. Atkin and Richard Larson two papers on combinatorics; several expository papers that she wrote in the late 1970s reflected her long concern with mathematical education. At her death she was serving as an Associate Editor of the American Mathematical Monthly.

A member of the AMS since 1958 and the MAA since 1962, Hay served on the AMS-MAA-SIAM Committee on the Status of the Profession (1983-1985) and represented the AMS at the AAAS (1986-1989). She served on many panels and committees devoted to the advancement of the profession. An active member of the Association of Symbolic Logic since 1959, Hay was Secretary of the Association from 1978 to 1982, served on the membership committee (1981-1984) and as the representative of the Association to the Conference Board on the Mathematical Sciences from 1978 to 1984. Hay was a founding member of the Association for Women in Mathematics. She served on the executive committee of that organization (1980-1982) and on its council from 1987 until her death.

Hay strongly advocated an increased role for women in mathe-

matics. An autobiographical memoir, published in the AWM Newsletter ["How I Became a Mathematician (or how it was in the bad old days)", September-October 1989, page 8], describes the many challenges she had to face and acknowledges the encouragement of established women mathematicians, specifically Hanna Neumann. She repaid that debt many times by her advice, both mathematical and practical. The many mathematicians she strongly affected include her two Ph.D. students, Nancy Johnson and Jean-Leah Mohrherr.

The key to Hay's effective Headship was her ability to rule democratically. She listened carefully to diverse opinions before making decisions. She strongly supported the Department's commitment to excellence in all branches of mathematics and led the remarkably successful effort to recruit faculty to fulfil that commitment. She will be long remembered as a mathematician, as an educator, and as a person.

John T. Baldwin
University of Illinois at Chicago

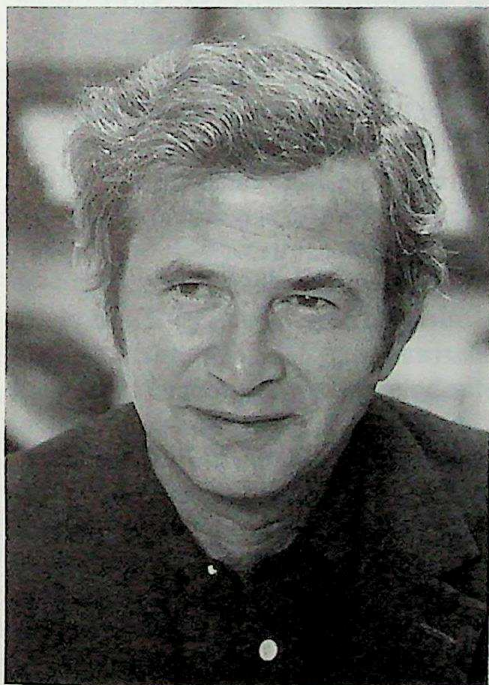
National Medals of Science Awarded

On October 18, 1989, President Bush awarded National Medals of Science to nineteen scientists, engineers, and mathematicians. The medal, the highest national award in science, is conferred by the President in recognition of outstanding contributions to the advancement of knowledge. Among the recipients were

three mathematicians, Samuel Karlin of Stanford University, Saunders Mac Lane of the University of Chicago, and Donald C. Spencer of Princeton University.

The National Medal of Science was established by Congress in 1959. Selection is based on the total impact and importance of an individual's work on the present state of his or her chosen field. In addition, achievements of an unusually significant nature are considered in relation to their potential effects on the development of scientific thought.

Samuel Karlin was awarded the National Medal of Science "for his broad and remarkable researches in mathematical analysis, probability theory and mathematical statistics, and in the application of these ideas to mathematical economics, mechanics, and population genetics."



Samuel Karlin

The Managing Editor of *Notices* asked Yosef Rinott of the University of California at San Diego to comment on Professor Karlin's research. Professor Rinott responded:

Samuel Karlin has made fundamental contributions in diverse areas of pure and applied mathematics including functional analysis, game theory and mathematical economics,

statistics, probability and stochastic processes, total positivity, approximation theory, and mathematical biology. His work encompasses a wide range of applications in inventory processes and queueing systems, operations research, population models in genetics, and statistical analysis and development of algorithms for identifying and evaluating patterns in DNA sequences.

The application of operator theory, fixed point theorems, total positivity, convexity and extreme point theory, moment spaces, integral equations and other analytic tools in advancing game theory, operations research, and mathematical economics marks Karlin's work in the early 1950s. His two volumes on *Mathematical Methods and Theory in Games, Programming and Mathematical Economics* (1959) have been a unique source of information for students and researchers.

In the early 1950s, inspired by I. J. Schoenberg, Karlin embarked on his longstanding involvement with the theory of Total Positivity. His research in the basic theory of this field, and the vast scope of applications he introduced, had a major impact on its development and recognition.

Totally Positive [TP] kernels (matrices) can be characterized by their variation diminishing property: they preserve or diminish oscillations in functions (vectors) when viewed as integral (matrix) transformations. Karlin's discovery of the relevance of total positivity in statistical decision theory and its ubiquity in statistical models, led to decisive results published in the 1950s, including central concepts such as monotone likelihood ratio and optimality properties of related classes of statistical tests. An important class of TP kernels comprise the transition kernels of continuous Markov processes (diffusions, birth-death processes). This was discovered via a beautiful identity connecting subdeterminants of the transition matrix to probabilities of certain events. The identity

itself later proved to be extremely useful in combinatorics. Orthogonal polynomial representations of transition kernels led to further discoveries of TP properties of various polynomial classes. With a wealth of results of the 1960s—e.g., on TP properties of first passage distributions and absorption probabilities—the significance of total positivity in mathematics was firmly established. A unified presentation of the basic concepts of total positivity and their refinements, and many ingenious applications in analysis, probability, differential equations and inequalities, appeared in Karlin's definitive *Total Positivity* volume in 1968.

In the early 1960s, Karlin's seminal lectures on multivariate statistical analysis contributed importantly (via unpublished lecture notes) to the development of tools, based on topological groups and invariance, for calculations of densities and distributions arising in statistics. Karlin also used these tools in the determination of TP properties of elaborate distributions.

TP properties of polynomial sequences and various classes of splines, and, more generally, of Tchebycheff systems and their significance in analysis, were investigated by Karlin in the 1960s and 1970s in papers and a book (1966, with W. J. Studden). Karlin's work in this period established the distinct role of Tchebycheff systems in analysis, interpolation and approximation theory, the geometry of moment spaces, inequalities and generalized convexity, and statistical experimental design.

The notions of oscillations and sign changes are essentially one dimensional. Karlin foresaw the potential for multivariate extensions of TP concepts, and some of his work in the 1980s provides theory in this direction. Multivariate TP concepts are related to the FKG condition in statistical mechanics and to multivariate log-concavity and generalized concavity, with applications in statistics, multivariate splines and approx-

imation theory, and multivariate inequalities.

Along with his work on total positivity, Karlin continued his powerful and penetrating research in areas such as stochastic processes, statistics, matrix theory and analysis. Some examples are his fundamental work (partly in collaboration with J. McGregor) on representations, classification and limit theorems in birth-death processes, renewal theory, urn models, and branching processes with constant and random environments; a variety of results on inequalities including matrix and operator eigenvalue inequalities, partly motivated by models in biology, which attained major significance in connection with large deviation theory; and basic results on properties of spline functions in interpolation and approximation. Karlin's classical textbook on stochastic processes, uniquely rich with interesting examples from many fields of science, is evidence of his capabilities as a teacher and educator.

Since the 1970s, much of Karlin's research endeavors were motivated by biology. In addition to his work in mathematical biology, Karlin became involved in data analysis in epidemiology and later in algorithms and statistical analysis for DNA sequences. Karlin objected to statistical analysis which is obscured by complex models whose assumptions are at best questionable, and his natural suspicion of dogma led to rejection of all-purpose packaged statistical programs. Instead, he developed his own data-driven statistical approach and efficient algorithms for its implementation. At the same time, his contact with the DNA data stimulated his recent elegant and influential work on stochastic properties of patterns and similarities in random letter sequences.

Karlin's outstanding scientific achievements attracted numerous scientists to seek his collaboration and advice, including over fifty Ph.D. students. His deep insight, scholarship,

curiosity and stamina profoundly inspired and stimulated others. Some of the work described above is joint with students and colleagues who joined Karlin on certain legs of his remarkable excursion in pure and applied mathematics.

The Managing Editor of *Notices* asked Marcus W. Feldman of Stanford University to comment on Professor Karlin's research in mathematical genetics. Professor Feldman responded:

In the early 1960s, Karlin began to apply work that he had done on branching processes to stochastic processes that arise in the evolution of small populations. He developed mathematical results for multitype branching processes with the total number of individuals conditioned to be a fixed number. This also resulted in fundamental results on the conditions under which diffusion approximations would be valid in describing the discrete time evolution of small, genetically variable populations.

Later in the 1960s and early 1970s, Karlin became interested in the mathematics of inbreeding and other restrictive systems of matings. Much of this work is described in his book, *Equilibrium Behavior of Population Genetic Models with Non Random Mating*. At this time, he also began his work on the mathematical theory of recombination and selection. Over the period from 1970 to 1979, in work with his students, he presented the first formal mathematical representations of selection on multigene systems. This involved a new representation of the recombination process as well as a classification of an important class of selection models in terms of Kronecker products of elementary matrices. In these studies, and his work on selection in subdivided populations, Karlin's power in matrix analysis and total positivity was frequently applied. Elegant stability criteria resulted from the spectral analysis of a wide variety of interesting matrices.

In the late 1970s and early 1980s, Karlin began work on evolution of continuously varying traits. To solve these problems, he proved elegant results about matrix linear fractional transformations. These studies introduced him to applications in human genetics and led to his statistical contributions in human genetic epidemiology. Here he introduced a class of exploratory statistical techniques to classify levels of familial aggregation for traits with complex patterns of inheritance. In these studies, he collaborated extensively with medical researchers.

In the early 1980s, he began to study models for the evolution of altruism that had achieved prominence in behavioral ecology. Often these studies have been linked with questions of the optimal sex-ratio in populations. Karlin became involved in sex-ratio studies in 1983, work which culminated in his book *Sex Ratio Evolution*, with Sabin Lessard, now at Montreal. The sex-ratio work ties together subjects such as restrictive mating systems and two-sex models of natural selection, showing how to view these as parts of a single mathematical framework.

In the past five years, much of Karlin's time has been devoted to applying stochastic processes and combinatorics to questions that arise in molecular biology. He has developed numerical algorithms for detecting patterns with DNA sequence as well as models for the distribution of lengths and organizational pattern of cloned DNA segments. This has recently been extended to analysis of proteins, where he has developed techniques for generating distributions of patterns of amino acids. Such patterns often suggest relations between the sequence and the function of specific parts of the protein.

In all of these applications to biology, Karlin has made it his practice to read widely in the biological literature and to become very familiar with the relevant empirical data. As a consequence, his work is published

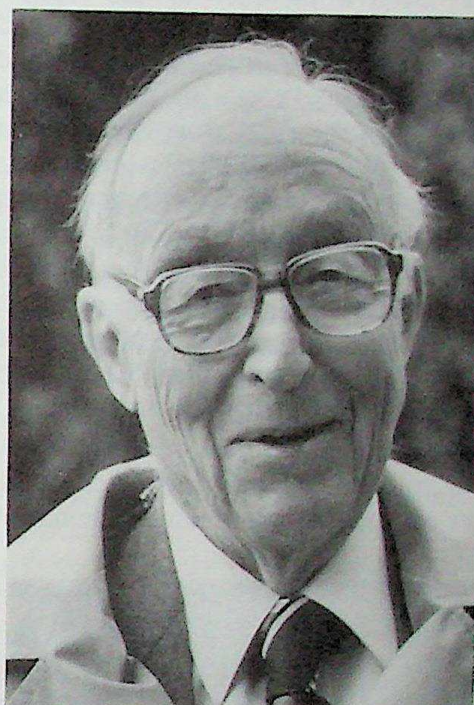
in the full array of population biology and molecular biology journals. He has had a profound influence on the direction and quality of research in mathematical biology of the past twenty-five years. It is probably fair to say that he has been the greatest reason for the legitimacy of mathematical biology as a central branch of applied mathematics.

Biographical Sketch. Samuel Karlin was born on June 8, 1924, in Yonova, Poland. He received his B.S. at the Illinois Institute of Technology in 1944 and his Ph.D. at Princeton University in 1947. He spent the next nine years at the California Institute of Technology, attaining the rank of professor in 1955. In 1956, he moved to Stanford University as Professor of Mathematics and Statistics; in 1978, he was named to his current position as the Robert Grimmer Professor of Mathematics.

Karlin has received numerous honors, including an honorary D.Sc. from Technion-Israel Institute of Technology and election to the National Academy of Sciences and the American Academy of Arts and Sciences. He has received the NAS Award in Applied Mathematics, the Lester R. Ford Award of the Mathematical Association of America, and the John von Neumann Theory Prize of the Operations Research Society of America. He also served as Andrew D. White Professor-at-Large at Cornell University from 1975 to 1981. Among the many named and invited lectures given around the world by Karlin are: the Josiah Willard Gibbs Lecture of the AMS, the Sir Ronald Fisher Lecture of the Royal Society of Britain, the First Mahalonobis Memorial Lecture of the Indian Statistical Institute, and the First Abraham Wald Memorial Lectures of the Institute of Mathematical Statistics, of which Karlin was president (1978-1979).

Saunders Mac Lane was awarded the National Medal of Science "for revolutionizing the language and content of modern mathematics by his

collaboration in the creation and development of the fields of homological algebra and category theory, for outstanding contributions to mathematics education, and for incisive leadership of the mathematical and scientific community."



Saunders Mac Lane

The Managing Editor of *Notices* asked J. Peter May of the University of Chicago to provide a sketch of the career and accomplishments of Professor Mac Lane. Professor May responded:

Saunders Mac Lane was born on August 4, 1909, in Norwalk, Connecticut. He was an undergraduate at Yale University (1926-1930) and a graduate student in mathematics at the University of Chicago (1930-1931). He spent 1931-1933 at the University of Göttingen, where he received his D.Phil. After brief stints at Yale (1933-1934), Harvard University (1934-1936), Cornell University (1936-1937), and Chicago (1937-1938), he taught at Harvard (1938-1947) and then at Chicago (1947-1982), where he served as chairman of the Department of Mathematics (1952-1958).

By their invention of homological algebra and category theory,

Mac Lane and his collaborators, especially Samuel Eilenberg, changed the language, and therefore also the content, of modern mathematics. Mac Lane also pioneered the development of many of the applications of homological algebra to topology and algebra, and he initiated several of the major areas of interest in category theory.

It is a truism that mathematical thought is limited by its means of expression. The clarity and beauty of the categorical language introduced by Eilenberg and Mac Lane revolutionized the way people think of mathematics. The machinery of homological algebra vastly extended the range and calculational power of such fields as algebraic topology and algebraic geometry. What is particularly striking is the philosophical depth and insight which Mac Lane has brought to his mathematics. The new language of category theory, for example, was directly influenced by Mac Lane's reading of Kant. It is the perfect harmony and evident rightness of the new categorical and homological language that led it to be adopted without change by mathematicians throughout the world. There are literally thousands of papers that have been written over the past 45 years that could not have been conceived and expressed without the language introduced by Eilenberg and Mac Lane.

Mac Lane has also been an exceedingly influential educator. The textbooks he wrote in collaboration with Garrett Birkhoff have changed the way that modern algebra is taught to undergraduates. His graduate-level textbooks are standard references. His many graduate students, several of whom are themselves among the leading American mathematicians, form a living legacy. His ebullient style of lecturing will long be remembered by those fortunate enough to have learned from him. Indeed, students at Chicago are fortunate enough to have that opportunity still. Mac Lane's energy and enthusiasm

are undimmed, and he is a regular participant in many seminars and a teacher of occasional courses.

Mac Lane's contributions to undergraduate education were recognized in 1975, when he was awarded the Distinguished Service Award of the Mathematical Association of America. His contributions to research mathematics and graduate education were recognized in 1986 when he was awarded the Steele Career Prize of the AMS.

Mac Lane also has had a long history of effective leadership of both the mathematical community and the broader scientific community in America. He has been president of the Mathematical Association of America (1951–1953), vice-president of the American Philosophical Society (1970–1971), and president of the AMS (1973–1974). He served as vice-president of the National Academy of Sciences (1973–1981) and chairman of its Report Review Committee; in the latter capacity, he worked very hard to improve the standards of the influential reports of the National Research Council. Concurrently, he served as a member of the National Science Board (1974–1980). His activities in these positions have had a significant impact on the development of science policy in the United States.

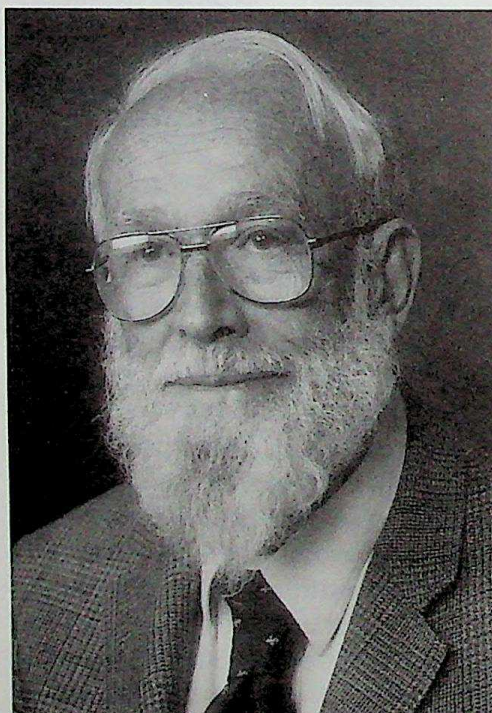
Mac Lane has also received several honorary degrees: the D.Sc. degree from Purdue University (1965), Yale University (1969), Coe College (1974), and the University of Pennsylvania (1977); and an LLD from Glasgow University (1971).

In addition to his academic appointments, Mac Lane served as Director of the Applied Mathematics Group at Columbia University (1944–1945) and as a member of the Executive Committee of the International Mathematical Union (1954–1958). He served as visiting professor at the University of Heidelberg (1958, 1965, 1976), the University of Frankfurt (1960), and Tulane Uni-

versity (1969). He held Guggenheim Fellowships in France and Switzerland, 1947–1948, and in England and Denmark, 1972–1973. In 1967, he was a Fulbright Fellow at the Australian National University.

Since 1933, Professor Mac Lane has been a member of the AMS. In addition to serving as president (1973–1974), he has been very active in Society affairs, serving as member-at-large of the Council (1939–1941), Editor of the *Bulletin* (1943–1947), Editor of *Transactions* (1949–1954), and Editor of the *Colloquium Series* (1966–1972).

Donald C. Spencer was awarded the National Medal of Science "for his original and insightful research that has had a profound impact on 20th-century mathematics, and for his role as an inspiring teacher to generations of American mathematicians."



Donald C. Spencer

The Managing Editor of *Notices* asked Professor J. J. Kohn of Princeton University to provide a sketch of Professor Spencer's career and accomplishments. Professor Kohn responded:

Donald C. Spencer was born on April 25, 1912 in Boulder, Colorado. He was an undergraduate

student at the University of Colorado (B.A. in physics, 1934) and at the Massachusetts Institute of Technology (B.S. in engineering, 1936). He received his postgraduate education at Cambridge University in England (Ph.D. 1939, Sc.D. 1963). His doctoral thesis, "On a Hardy-Littlewood problem of diophantine approximations and its generalizations," which was completed under the direction of J. E. Littlewood, initiated Spencer's remarkable mathematical career. Spencer taught at MIT (1939–1942), Stanford University (1942–1949, 1963–1968), and at Princeton University (1949–63, 1968–1978). His honors and distinctions include: Eugene Higgins Professor at Princeton (1971–1972), Henry Burchard Fine Professor at Princeton (1972–1978), Sc.D. honoris causa from Purdue University (1971), Scott Visiting Professor of Mathematics at the University of Pennsylvania (Fall, 1964), joint recipient with A. C. Schaeffer of the Bôcher Memorial Prize (1948), elected to the National Academy of Sciences (1961) and to the American Academy of Arts and Sciences (1967), Colloquium Lecturer at the AMS summer meeting (1968). In 1978, he retired from Princeton as Henry Burchard Fine Professor Emeritus. He has served on several editorial boards, including *Proceedings of the National Academy of Sciences U.S.A.*, *Annals of Mathematics*, *Transactions of the AMS*, *American Journal of Mathematics*, *Journal of Differential Geometry*, and *Advances in Mathematics*.

A representative selection of Spencer's papers has been reprinted in *Selecta Donald C. Spencer* (volumes I–III, World Scientific Publishing, Singapore, 1985). He has also co-authored four very influential books: *Coefficient Regions for Schlicht Functions*, with A. C. Schaeffer (AMS Colloquium Publications, volume 35, New York, 1950); *Functions of Finite Riemann Surfaces*, with M. Schiffer

(Princeton University Press, 1954); *Advanced Calculus*, with H. K. Nickerson and N. E. Steenrod (Van Nostrand, Princeton, NJ, 1959); and *Lie Equations, Volume I: General Theory*, with A. Kumpera (Annals of Math. Studies No. 73, Princeton University Press, 1972).

Spencer's mathematical work is truly impressive and spans many fields in which he has made fundamental contributions. Before coming to Princeton, he worked in number theory, on lattice points and on sequences of integers; in applied mathematics, on fluid mechanics; and in the theory of functions of one complex variable, on mean-valent functions, schlicht functions, conformal mappings, and Riemann surfaces.

At Princeton, Spencer's research turned to the study of several complex variables and complex manifolds. In joint work with K. Kodaira, the use of potential-theoretic methods in the study of complex manifolds was developed into a major tool, the basis for a large body of subsequent research. They introduced the modern theory of deformations of complex and other structures. This work has had tremendous influence in large segments of mathematics, especially in algebraic geometry and recently in mathematical physics. The excitement of these discoveries is conveyed in a paragraph from the preface to Kodaira's book *Complex Manifolds and Deformation of Complex Structures* (Springer-Verlag, 1981):

"... Spencer and I conceived a theory of deformation of compact complex manifolds which is based on the primitive idea that, since a compact complex manifold M is composed of a finite number of coordinate neighborhoods patched together, its deformation would be a shift in the patches. Quite naturally it follows from this idea that an infinitesimal deformation of M should be represented by an element of the cohomology group $H^1(M, \Theta)$ of M with coefficients in the sheaf Θ of germs of

holomorphic vector fields. However, there seemed to be no reason that any given element of $H^1(M, \Theta)$ represents an infinitesimal deformation of M . In spite of this, examination of familiar examples of compact complex manifolds M revealed a mysterious phenomenon that $\dim H^1(M, \Theta)$ coincides with the number of effective parameters involved in the definition of M . In order to clarify this mystery, Spencer and I developed the theory of deformation of compact complex manifolds. The process of the development was the most interesting experience of my whole mathematical life. It was similar to an experimental science developed by the interaction between experiments (examination of examples) and theory."

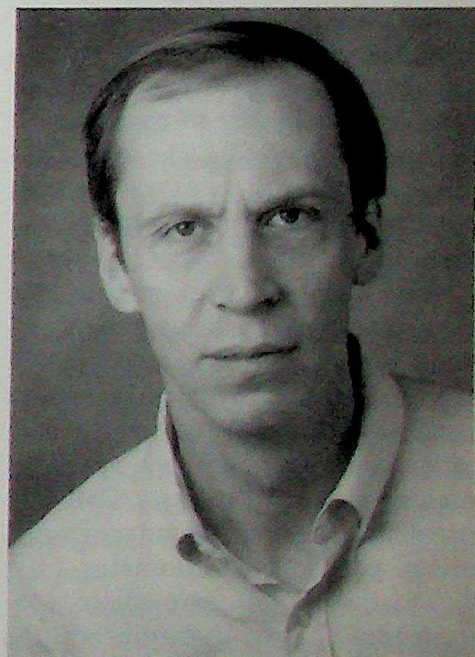
Also during this period, Spencer introduced the use of potential theory in the study of complex manifolds with boundaries, and, in particular, formulated the " $\bar{\partial}$ -Neumann problem," which has led to very important new developments in both several complex variables and partial differential equations. In the 1960s, Spencer worked on overdetermined systems of partial differential equations and on pseudogroups. The culmination of this period has been the seminal joint work with H. Goldschmidt on Lie equations.

In all his work, Spencer shows remarkable originality and insight. His influence on his students, his collaborators, and his many friends has also had a lasting impact on 20th-century mathematics. Just as Spencer had an unfailing instinct in how to approach mathematical research, so he also had an unfailing instinct in how to inspire both students and fellow mathematicians. His patience and his dedication knew no limits, and his enthusiasm was contagious. His students were a very individualistic lot, with different interests and different talents. Yet Spencer knew how to guide and lead them to use their talents in the most effective way.

Since his retirement in 1978, Spencer has lived in Durango, Colorado. He is very active in the ecology movement and is an avid hiker. He still keeps up with his many students and friends; his advice and help are always generously given and gratefully received.

First Bergman Prize to David Catlin

David W. Catlin of Purdue University has been named as the first awardee of the Stefan Bergman Trust. The trust, established in 1988, recognizes mathematical accomplishments in the areas of research in which Stefan Bergman worked. The prize awards Professor Catlin approximately \$20,000 per year for two years.



David W. Catlin

Stefan Bergman is best known for his research in several complex variables and the Bergman projection and the Bergman kernel function which bear his name. A native of Poland, he taught at Stanford for many years and died in 1977 at the age of 78. He was an AMS member for 35 years. When his wife died recently, the terms of her will stipulated that funds should go toward a special prize in her husband's honor.

The AMS was asked by Wells Fargo Bank of California, the managers of the Bergman Trust, to assemble a committee to select recipients of the prize. In addition, the Society assisted Wells Fargo in interpreting the terms of the will to assure sufficient breadth in the mathematical areas in which the prize may be given. Awards will be made every two years in the following areas: 1) The theory of the kernel function and its applications in real and complex analysis; 2) Function-theoretic methods in the theory of partial differential equations of elliptic type with attention to Bergman's operator method.

Description of Catlin's work. In two papers from 1983 and 1987, Professor Catlin obtained a spectacular result: the $\bar{\partial}$ -Neumann problem on a pseudo-convex domain Ω is subelliptic at a point P in the boundary of Ω if and only if P is of finite type (i.e., every complex analytic curve through P has bounded order of contact with the boundary of Ω). The proof involves several entirely new ideas both in partial differential equations and in several complex variables, such as a novel and powerful method for constructing plurisubharmonic functions, a very ingenious stratification of pseudo-convex hypersurfaces, and a technique for quantifying the geometric analysis of finite types. This analysis also led Professor Catlin to establish important boundary invariants of pseudoconvex domains.

This work has immediate consequences for the behavior of the Bergman projection and of the Bergman kernel function. In fact, Professor Catlin's results imply that the Bergman projection preserves smoothness near P and that the Bergman kernel function is C^∞ off the diagonal near P , and also gives some control of singularities on the diagonal.

Related questions of global regularity were also addressed by Professor Catlin, with striking results and highly powerful and original techniques. Another remarkable series of

results were presented in a recent paper, in which Professor Catlin shows that the Kobayashi, Carathéodory, and Bergman metrics are equivalent to pseudo-convex domains of finite type in C^2 . He also gives sharp estimates for the singularities of the Bergman kernel function restricted to the diagonal on such domains. Other important research directly related to Bergman's ideas are Professor Catlin's work on proper and CR mappings with Bedford and Bell. Professor Catlin has also achieved fundamental results in areas somewhat further from Bergman's work, such as holomorphic functions on pseudoconvex domains and a far-reaching generalization of Kuranishi's embedding theorem.

Apart from Professor Catlin's published work, he has obtained a series of important results (several of which involve the Bergman operator) which he has not published but has explained to many of his colleagues. In this way, these results have become part of the general common knowledge in the field.

Biographical sketch. David Catlin was born on May 12, 1952 in Rochester, Pennsylvania. He received his B.S. from the University of Michigan in 1974 and his Ph.D. in 1978 from Princeton University, where his thesis advisor was J. J. Kohn. Serving as an instructor at the University of Chicago from 1978 to 1980, Catlin moved to Princeton University as an assistant professor in 1980. In 1983, he received a Sloan Fellowship and moved to Purdue University as an associate professor in 1984. He is currently professor of mathematics at Purdue.

Professor Catlin has presented many invited addresses, including the AMS Special Session on Pseudo-differential operators in Denver in 1983, the International Congress of Mathematicians in Berkeley in 1986, and the Summer Symposium on Several Complex Variables in Santa Cruz in 1989.

Kahan to Receive Turing Award

William M. Kahan of the University of California at Berkeley will receive the 1990 Turing Award from the Association for Computing Machinery (ACM). The award will be presented during the ACM Computer Science Conference in Washington, DC in February, 1990. Professor Kahan will receive the award for his "outstanding research in numerical analysis and his leadership in developing standards to compute accurately and confidently with floating-point numbers."

One of the foremost experts on floating-point computations, Professor Kahan has dedicated himself to "making the world safe for numerical computations." He has spent the last decade spearheading the effort to develop and adopt two standards (IEEE 754 and 854) for binary and radix-independent floating-point numbers. This project succeeded primarily because of Kahan's commitment to provide as clean an interface to software as possible and his deep knowledge of mathematical analysis, computer floating-point systems, hardware, and pertinent aspects of operating systems and software. Today, the binary standard has been adopted by nearly every computer and chip manufacturer. Professor Kahan used the power of numerical analysis to significantly influence computer architecture, a unique and unusual contribution that will have an impact on virtually anyone who will use a computer in the future.

Professor Kahan received his Ph.D. in numerical analysis in 1958 from the University of Toronto. He held a National Research Council of Canada fellowship at Cambridge University from 1958 to 1960 before returning to the University of Toronto as a faculty member in mathematics and computer science. In 1969, he moved to the University of California at Berkeley, where he is currently professor of mathematics

electrical engineering, and computer science at Berkeley.

National Teaching Awards to Mathematicians

Three mathematics faculty have received awards from the Council for Advancement and Support of Education (CASE). The awards were given in recognition of teaching ability, service to their institutions and professions, dedication to teaching and scholarship, and achievement of former students.

ROBERT S. DORAN of Texas Christian University and ZAFRA MARGOLIN LERMAN of Columbia College in Illinois received gold medals. Professor Doran was also named 1989 Texas Professor of the Year by CASE. WILLIAM L. HART of Macomb Community College in Michigan was named 1989 Michigan State Professor of the Year.

Nationwide, 11 gold medalists and 38 State Professors were recognized for their achievements. They were chosen by 35 panelists from the higher education community. The panel also supplied nominations to the Carnegie Foundation for the Advancement of Teaching, which chose the medalists.

CASE began the Professor of the Year program to recognize undergraduate faculty members for their contributions to the lives and careers of students. CASE, with a membership of 2850 colleges, universities, and independent schools, seeks to advance public understanding and support of education for the benefit of society.

Fulbright Scholars Named

The Council for International Exchange of Scholars has announced that approximately 900 scholars, academics, and professionals have received awards under the Fulbright Scholar Program to lecture, consult, and conduct research abroad in 1989-1990. The Council, an affiliate of the

American Council of Learned Societies, cooperates with the United States Information Agency in administering the Fulbright program.

The following are the Fulbright Scholars in the mathematical sciences, with their institutional affiliation and the countries they will visit. ALKIVIADIS G. AKRITAS, University of Kansas, U.S.S.R.; DEANE E. ARGANBRIGHT, Whitworth College; Papua New Guinea; SHRIKANT I. BANGDIWALA, University of North Carolina at Chapel Hill, Costa Rica; STRAVOS N. BUSENBERG, Harvey Mudd College, New Zealand; DAVID W. CLAY, Florida Institute of Technology, Lesotho; JAMES E. FALK, George Washington University, Czechoslovakia; M. DEAN FENTON, Pennsylvania State University, Liberia; LOUIS GORDON, University of Southern California, Israel; RONALD R. GOFORTH, University of Arkansas at Fayetteville, Fiji; OMAR B. HIJAB, Temple University, Jordan; RALPH N. MCKENZIE, University of California at Berkeley, Australia; AMAR MUKHERJEE, University of Central Florida, India; SYED SHAHABUDDIN, Central Michigan University, Pakistan; PAUL C. SHIELDS, University of Toledo, Hungary; GERARD A. VENEMA, Calvin College, Yugoslavia; ANDREW J. VINCE, University of Florida, Malawi; PETER B. VON MERTENS, Lesley College, Tanzania; JAMES E. WARD, Bowdoin College, Lesotho; and JOSEPH E. YUKICH, Lehigh University, France.

American Association of University Women Fellowships and Grants

The Educational Foundation of the American Association of University Women has announced the awarding of fellowships and grants to women amounting to more than \$1.4 million. The 91 American recipients will do postdoctoral research, complete doctoral dissertations, or enter the final year of study for selected professions.

Of these recipients, one is in the mathematical sciences. Wilhelmina Claus, University of Texas at Austin, received a dissertation fellowship. The subject of her dissertation is Kleinian groups and 3-manifolds.

For more information about the American Association of University Women fellowships, see the December 1989 issue of *Notices*, page 1455.

NSF Grants to Minority Institutions

The National Science Foundation has announced awards totalling more than \$4 million to colleges and universities with substantial minority enrollments. These grants are designed to improve the research capabilities of these institutions.

The program, entitled Research Improvements in Minority Institutions, is intended to improve research and training by supporting faculty research and student participation, research equipment acquisition, and cooperative research between industry and academia. In addition, this program is designed to enhance the ability of historically black colleges and universities to participate in federally-sponsored programs.

Grants were made in a broad range of science and engineering fields. Of the 15 grants, two were in the mathematical sciences. A brief description of each of these grants follows.

Howard University in Washington, DC, will establish a differential equations and applied mathematics group focusing on the study of non-linear differential equations and applications to fluid dynamics and water waves. Computer facilities will be expanded to strengthen graphics capabilities in the mathematics department. The amount of this three-year grant is \$330,000.

University of Puerto Rico, Mayaguez will implement comprehensive applied and computational mathematics efforts that will significantly increase the research capability of

faculty and students. The amount of this three-year grant is \$258,408.

An Open Letter to the Mathematical Sciences Community

The Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) faces many important, difficult policy questions in the coming years. At the November 1989 meeting of the Advisory Committee, four subcommittees were established to examine four of the most pressing issues. Membership and a brief outline of the issues for each committee are given below. The committee chairs and members welcome the comments of all members of the mathematical sciences community. Recommendations of other issues which deserve in-depth study should be made directly to us (Michael C. Reed, Department of Mathematics, Duke University, Durham, NC 27701, reed@cs.duke.edu; Judith S. Sunley, National Science Foundation, Division of Mathematical Sciences, 1800 G Street, N.W., Washington, DC 20550, jsunley@note.nsf.gov).

Committee on Research Funding: S.Y.A. Chang, S.-N. Chow, F. Morgan, A. Odlyzko, J. Sally, B. Speh, J. Sunley (DMS), C. Taubes, J. Goldstein (chair), Department of Mathematics, Tulane University, New Orleans, LA 70118, mt0namf@vm.tcs.tulane.edu.

What kinds of non-salary resources do mathematicians really need? Should the distribution of such resources in the mathematical sciences community be broadened? What modes of funding would be administratively efficient, permit quality control, and have the support of the community? If the total DMS budget remains flat or increases only slowly, how shall funding for such alternate modes be found? Cut the number of Principal Investigator awards with salary? Impose a salary cap? Cut other activities?

Committee on Computation and Departmental Awards: A. Odlyzko, B. Speh, A. Thaler (DMS), M. Wheeler, T. Kurtz (chair), Department of Mathematics, University of Wisconsin, Madison, WI 53706, kurtz@vanleck.math.edu.

Should the DMS continue to support computer services and hardware purchases? How should such support be organized? What are the benefits and drawbacks (scientific and administrative) of DMS awards to departments rather than to individuals?

Committee on Undergraduate Education: D. Blackwell, J. Bustoz, D. Lockhart (DMS), F. Morgan, D. Sanchez, J. Cannon (chair), Department of Mathematics, Brigham Young University, Provo, UT 84602.

What kinds of programs make sense for the NSF, for the DMS? Which should be developed cooperatively with the Directorate for Science and Engineering Education? How can the NSF stimulate the recruitment of women and minorities into mathematics? How large should the DMS's budget commitment to these activities be?

Committee on Industrial Cooperation: M. E. Bock (DMS), J. Bustoz, R. Chin (formerly DMS), S.-N. Chow, A. Manitius (formerly DMS), M. Wheeler (chair), Department of Mathematics, University of Houston, Houston, TX 77004, mfw@rice.edu.

What modes of cooperation with industry are natural and beneficial for mathematicians and mathematical sciences departments? How can the DMS encourage such cooperation?

Michael C. Reed, Chair
DMS Advisory Committee
National Science Foundation

Judith S. Sunley, Director
Division of Mathematical Sciences
National Science Foundation

Summer Math Program for Minorities

In an effort to increase the number of underrepresented minority students

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seeking careers requiring a Ph.D. in mathematics, the University of California at Berkeley will offer a six-week summer residential program for undergraduate students, from June 18 to July 27, 1990. The program is being organized by Leon Henkin of U.C. Berkeley, and by Uri Treisman of Swarthmore College and the Dana Center for Math and Science Education at U.C. Berkeley. Support for the program is expected from the Alfred P. Sloan Foundation and the National Science Foundation. Mathematics faculty are asked to encourage promising students to apply.

To be eligible, a student must be African-American, Mexican American/Chicano, Latino, or American Indian and enrolled at a college or university offering a bachelor's degree in mathematics. In addition, the student must have completed with distinction two years of undergraduate mathematics, beginning with calculus, by June, 1990.

Each participating student will receive room and board, a \$2000 stipend, and travel to and from Berkeley. Students will be expected to work intensively in two of five introductory seminars. In addition, there will be a dozen special colloquium talks delivered by senior mathematicians designed to give students a broad view of current developments in mathematics and its applications. Participants will work individually and in groups on challenging mathematical problems arising from the seminars and colloquia.

The deadline for student applications is **March 1, 1990**. Application forms and further information can be obtained by writing to: Dana Center PDP/Summer Math Institute, 230 Stephens Hall, U.C. Berkeley, Berkeley, CA 94720.

Faculty for the Institute will be drawn nationwide from universities or research laboratories. Interested faculty are invited to contact Leon Henkin, Department of Mathematics, U.C. Berkeley, Berkeley, CA 94720.

News from the Mathematical Sciences Institute Cornell University

The Mathematical Sciences Institute (MSI) has announced its spring roster of workshops. Among them are two contiguous workshops on computer algebra: Computer Algebra and Differential Equations (CADE-90) and Computer Algebra and Parallelism (CAP-90). They have been organized as back-to-back workshops from May 6-12 so that scientists and mathematicians with overlapping interests can easily arrange to attend both.

Organized by Michael Singer, North Carolina State University; Evelyn Tournier, IMAG, Grenoble; and Richard Zippel, Cornell University, CADE-90 will be held May 6-9, 1990. The aim of the workshop is twofold: to allow researchers in computer algebra to learn about recent theoretical developments concerning differential equations and to make researchers in theoretical areas aware of questions arising in the design of computer algebra systems.

Peter J. Olver, University of Minnesota, as the principal speaker, will give four lectures, including an introduction to Lie group methods in differential equations. Other invited speakers include G. Almkvist, D. Babbitt, A. Duval, R. Grossman, J. Guckenheimer, A.H.M. Levelt, C. Mitschi, and Y. Sibuya. They will lecture on topics such as perturbation theory, summation and integration in finite terms, effective methods in the theory of D -modules, differential Galois theory, and resummation techniques. Additionally, the workshop will feature one or two presentations of software projects, such as DESIR, that integrate computer algebra and differential equations. No more than four lectures will be delivered each day to allow time for informal discussion.

Organized by Jean Della Dora, IMAG, Grenoble; John Fitch, University of Bath; Erich Kaltofen, Rensselaer Polytechnic Institute; and

Richard Zippel, Cornell University, CAP-90 will be held May 9-12, 1990. The aim of the CAP-90 workshop is to allow computer algebra users to learn about recent theoretical developments in the design of parallel algebraic algorithms and to provide an opportunity for researchers working on theoretical issues in parallel algebraic computation to become aware of problems that arise when mapping these algorithms onto existing parallel computers.

Workshop topics include vectorized long integer arithmetic, parallel expression evaluation, parallel linear and nonlinear system solving, parallel sparse interpolation, and parallel polynomial root finding. Implementing parallel algebraic algorithms on parallel computers also will be discussed.

One-hour lectures by the following invited speakers will highlight the workshop: J. von zur Gathen, B. Halstead, M. Karpinski, D. Kozen, G. L. Miller, W. Neun, B. S. Saunders, and E. Sibert. Time has been reserved for discussion sessions and impromptu presentation of ongoing research. It is expected that workshop participants will have access to Cornell's Supercomputing Facility.

Scientists interested in attending either workshop should contact the Mathematical Sciences Institute, Cornell University, 201 Caldwell Hall, Ithaca, NY 14853-2602, 607-255-8005.

Other workshops scheduled for this spring include Percolation Models of Material Failure, May 31-June 3, 1990, organized by S. Leigh Phoenix and Function Estimation and Statistical Applications, June 13-16, 1990, organized by David Rupert and J. S. Marron. They will be described in detail in future columns.

MSI is sponsoring a major symposium on "Modern Perspectives of Mathematics: Mathematics as a Consumer Good, Mathematics in Academia," March 29-31, 1990, at Cornell University. See this column in the November *Notices* and the dis-

play advertisement in this issue for a full description. Registration packets are now available. Contact conference secretary Diana Drake at the same address and phone number listed above.

Science-by-Mail for Youngsters

The Science-by-Mail program was developed in 1987 by the Boston Museum of Science. The purpose of the program is to form ties between children and professional scientists in order to address the growing problem of science illiteracy. *Notices* readers may be interested in becoming a part of this important and rewarding activity.

Science-by-Mail exposes children in grades 4-9 to the exciting world of science through activity packets and correspondence with a scientist pen-pal. Each student participant receives three "science challenge packets" during the school year. After completing the activities in the packet, the children send their solutions to an assigned scientist, who responds to their ideas through letters.

Currently, more than 300 scientists volunteer their time to Science-by-Mail. They serve as important role models, especially to girls, minorities, and disadvantaged students who might otherwise receive little or no exposure to science and science careers.

Several museums and science centers around the world have established Science-by-Mail chapters to distribute materials to children and scientists in their areas, and many other museums have expressed interest in starting chapters. The program has also attracted the interest and support of several scientific associations.

If you would like to become a scientist pen-pal, or if you know of children who might like to participate in this program, please call Thea Sahr, 1-800-729-3300 or 617-589-0438, or write to her at Science-

by-Mail, Museum of Science, Science Park, Boston, MA 02114-1099.

Math Kits for Elementary Schoolers

"Math Matters: Kids are Counting on You" is a kit of educational materials prepared by the National Parent-Teachers Association (PTA) for the parents of elementary school children. The kit uses common household items to make mathematics homework an interactive and exploratory experience for parents and children.

Developed in cooperation with the Mathematical Sciences Education Board (MSEB) of the National Research Council, "Math Matters" is centered on the premise that parental attitudes about mathematics exert a crucial influence on children's perceptions of the difficulty and value of the subject. The kit is designed to foster positive attitudes about mathematics and to build children's confidence in doing it. In addition, the kit helps to build parents' competence in mathematics.

The kit provides 70 simple and interesting parent-tested activities that can be used at home. Parents need not be mathematical or educational experts to use the kit. The exercises are fun and accessible, usually with no "right or wrong" answers. They use everyday objects and situations to get kids to think about numbers, shapes, and patterns.

A copy of the "Math Matters" kit has been sent to each PTA president in 30,000 elementary schools and to 20,000 elementary school principals. Demand for the kits has exceeded original supplies, but the MSEB recently had several hundred more kits printed.

Notices readers may be interested in obtaining the kit either for use with their own children or to insure that the kits are being used in their

own communities. The kits are not copyrighted and may be reproduced. They are available for \$10 (prepaid) from the MSEB. For further information, contact Ann Kahn, Mathematical Sciences Education Board, 818 Connecticut Avenue, NW, Suite 500, Washington, DC 20006; telephone 202-334-3294.

New Phone Numbers for the AMS

The toll free telephone number to contact the American Mathematical Society has recently been changed to 800-321-4AMS. With this change, it is now possible to use the toll free number from Canada as well as within the United States.

In addition, the Society's main telephone number has been changed to 401-455-4000. If you know the extension for the individual or department you are trying to reach, you can now contact them directly by dialing 401-455 plus the 4-digit extension.

Change in the Mathematical Sciences Meetings and Conferences Section of Notices

Effective with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than that twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the next complete list is published in a September issue or until the date of the meeting or conference falls within the twelve-month period.

Changes in NSF Proposal Format

In the October issue of *Notices* an NSF Important Notice described forthcoming changes in the format of proposals. For administrative reasons, the Mathematical and Physical Sciences Directorate has delayed full implementation of the new requirements to January 3, 1990. All proposals received after that date must be in the new format.

The Division of Mathematical Sciences is in the process of drafting a letter to the mathematical community that will describe the Division's expectations under the new guidelines. It will be mailed to department chairs shortly and will be available at the NSF booth during the Louisville Joint Mathematics Meetings.

Errata

Survey of American Research Journals
The *Survey of American Research Journals*, published in the November issue of *Notices*, incorrectly listed 1988 pages and corresponding cents per thousand character figures for the Pacific Journal of Mathematics. The figure for pages published in 1988 should read 1996 and the cents per thousand character figure should read 4.3.

Allen Shields

In the December 1989 issue of *Notices* (page 1452), the date of Allen Shields' death was incorrectly published as September 23, 1989. He in fact died on September 16, 1989 and a memorial service was held in Ann Arbor, Michigan on September 24, 1989. The managing editor sincerely regrets this error.

Funding Information for the Mathematical Sciences

NAS Soviet and East European Exchanges

The National Academy of Sciences (NAS) sponsors exchange programs of individual scientists with the Academies of Sciences of the U.S.S.R., Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Poland, Romania, and Yugoslavia. The programs cover a range of scientific disciplines, including mathematics and computer science.

The purpose of the programs is to facilitate exchanges that will lead to significant scientific publications jointly authored by U.S. and foreign colleagues in areas of high scientific interest. In addition, the programs are intended to contribute to sustained cooperative research between U.S. and foreign colleagues. Visits designed primarily to present lectures or to attend conferences are not supported by this program.

For *Survey and Research Visits*, each participating country has an "exchange quota," specifying a limit on the number of person-months of scientific visits that may be exchanged in the program. For example, the exchange quota for the Soviet Union is 50 months, meaning that the total the number of months spent in the U.S.S.R., summed over all program participants, may not exceed 50. In addition, the exchanges are always one-for-one; for example, there must be a corresponding 50 person-months of Soviet visits to the U.S.

To be eligible for the program, applicants must be U.S. citizens and must have a doctoral degree (or research and training experience equivalent to a doctorate) by June 1990. Previous exchangees may not apply to the program in consecutive years, and the time between long-term visits (3-12 months) must be at least three years.

Up to 25% of the quota for each country is set aside for young scientists, those who have received their doctorates within the past six years. Unused portions of this set-aside will be made available to other scientists.

At the request of the National Science Foundation (NSF), a new category of *Project Development Visits* was added this year. The purpose is to give U.S. researchers opportunities to develop plans for long-term cooperative research. These two-week visits are to be spent at a single institution, where NSF proposals can be developed. Visits to Eastern Europe may be in any area supported by the NSF. For the U.S.S.R., the program will support certain subfields of several scientific fields. Mathematics and theoretical physics are included; the NAS will supply a list of the subfields supported.

Project Development Visits may take place between April 1990 and December 1990, and Survey and Research Visits between January 1991 and December 1991. The deadline for applications for both is **February 28**. For more information, contact

Office of International Affairs, National Research Council, 2101 Constitution Avenue, Washington, DC 20418; telephone 202-334-2644.

OTA Congressional Fellowship Program

The Office of Technology Assessment (OTA) is seeking outstanding candidates from academia, business and industry, and the public sector for its Congressional Fellowship Program. Up to six Fellows will be selected for a 1-year appointment in Washington, DC, beginning in September, 1990.

OTA provides congressional committees with objective analyses of the emerging, difficult, and often highly technical issues of today. Assessments are conducted in such areas as economic competitiveness, international security, energy, advanced materials, biotechnology, neuroscience, agriculture, advanced medical technologies and services, telecommunications and information technologies, environment, education, and science policy.

Candidates must have significant experience in technical fields or management or have completed research at the doctoral level. The deadline for applications is **January 31**. For more information, contact: Congressional Fellowships, Personnel Office, Office of Technology Assessment, Congress of the United States, Washington, DC 20510-8025; telephone 202-224-8713.

For Your Information

Afrika Matematika, Journal of the African Mathematical Union

*Harley Flanders**

Last September, the African Mathematical Union (AMU) held, for the first time, an International Symposium, in Arush, Tanzania. The symposium, attended by about 50 of the leading senior mathematicians of Africa (plus three outsiders), covered "current research trends in mathematics, computer science, mathematics education, and industrial mathematics", and lasted a full week. It was indeed an extraordinary meeting, and I was pleased by the very high quality of the presentations. The symposium was sponsored by UNESCO, ANSTI, ICTP, the Tanzanian Commission for Science, and the University of Dar-es-Salaam.

Needless to say, the AMU operates under difficult conditions of finance and communications. After a lapse of several years, it has resumed publication of its journal, Afrika Matematika. I have been requested by the AMU to bring its publication to the attention of my colleagues here, in the hope that libraries and individuals will support the journal by subscriptions. There follows Professor Iyehen's announcement:

Afrika Matematika

The publication of Afrika Matematika started in 1978. A refereed journal, it provides an outlet for some of the mathematical research done in Africa, as well as other parts of the world. The journal also publishes in-depth research studies on the problems of the teaching

of mathematics in Africa. The official languages of Afrika Matematika are English and French. The annual subscription is \$20.00 US. This may be paid to

Professor Wouafo Kamga, Treasurer
African Mathematical Union
c/o Department of Mathematics
University of Yaounde
Yaounde, Cameroons (Africa)

Afrika Matematika publishes short, medium, and fairly long research articles in all areas of mathematics, its applications, and mathematics education. It also publishes commissioned survey articles. Papers published or being considered for publication elsewhere are not accepted. However, abstracts may be published elsewhere. Articles to be published in full in Afrika Matematika

Series 2 of the journal commenced in 1988. From now, one issue is published a year, however, from 1990 there will be two issues per year, April and October. Research reports of conferences and workshops organized under the auspices of the African Mathematical Union are published in special issues of the journal. Further information about Afrika Matematika may be obtained from the Editor-in-Chief,

Professor Su-day O. Iyehen
Department of Mathematics
and Computer Science
University of Benin
Benin City, Nigeria (Africa)

*Harley Flanders is a Professor of Mathematics at the University of Michigan.

Manhattan, Kansas

Kansas State University

March 16 – 17

Second Announcement

The eight-hundred-and-fifty-fifth meeting of the American Mathematical Society will be held at Kansas State University in Manhattan, Kansas on Friday, March 16, and Saturday, March 17, 1990.

Invited Addresses

By invitation of the Central Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, and the titles of their talks where available are:

J. BRIAN CONREY, Oklahoma State University, Stillwater, *Modular forms and the Riemann zeta-function*.

STEWART B. PRIDDY, Northwestern University, *Representation theory and stable homotopy of finite groups*.

JEAN-PIERRE ROSAY, University of Wisconsin, Madison, *Examples of Cauchy-Riemann structures*.

JANG-MEI WU, University of Illinois at Urbana-Champaign, *Harmonic measure and applications*.

Special Sessions

By invitation of the same committee, there will be eleven special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Harmonic analysis and probability theory, ANDREW G. BENNETT, Kansas State University.

Orthostructures, DAVID J. FOULIS, University of Massachusetts at Amherst, and RICHARD J. GREECHIE, Kansas State University.

Numerical analysis, KADOSA M. HALASI and QISU ZOU, Kansas State University.

Geometric function theory, DAVID H. HAMILTON, University of Maryland, College Park, and JOHN F. ROSSI, Virginia Polytech Institute and State University.

Partial differential equations, LIGE LI, Kansas State University.

Commutative algebra, SATYAGOPOL MANDAL, University of Kansas.

Inverse problems and scattering theory, ALEXANDER G. RAMM, Kansas State University.

Ergodic theory, JOSEPH M. ROSENBLATT, Ohio State University.

Graph theory, RICHARD H. SCHELP, Memphis State University.

Groups and geometries, ERNEST E. SHULT, Kansas State University.

Applications of category theory, GEORGE E. STRECKER, Kansas State University.

Abstracts for consideration for these sessions should have been submitted by the **November 21, 1989** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Late papers will not be accommodated.

Registration

The registration desk will be located inside the main entrance to Cardwell Hall, and will be open from 8:00 a.m. to 5:00 p.m. on Friday, March 16, and on Saturday, March 17, from 8:00 a.m. to noon. The registration fees are \$30 for members of the AMS, \$45 for nonmembers, and \$10 for students or unemployed mathematicians.

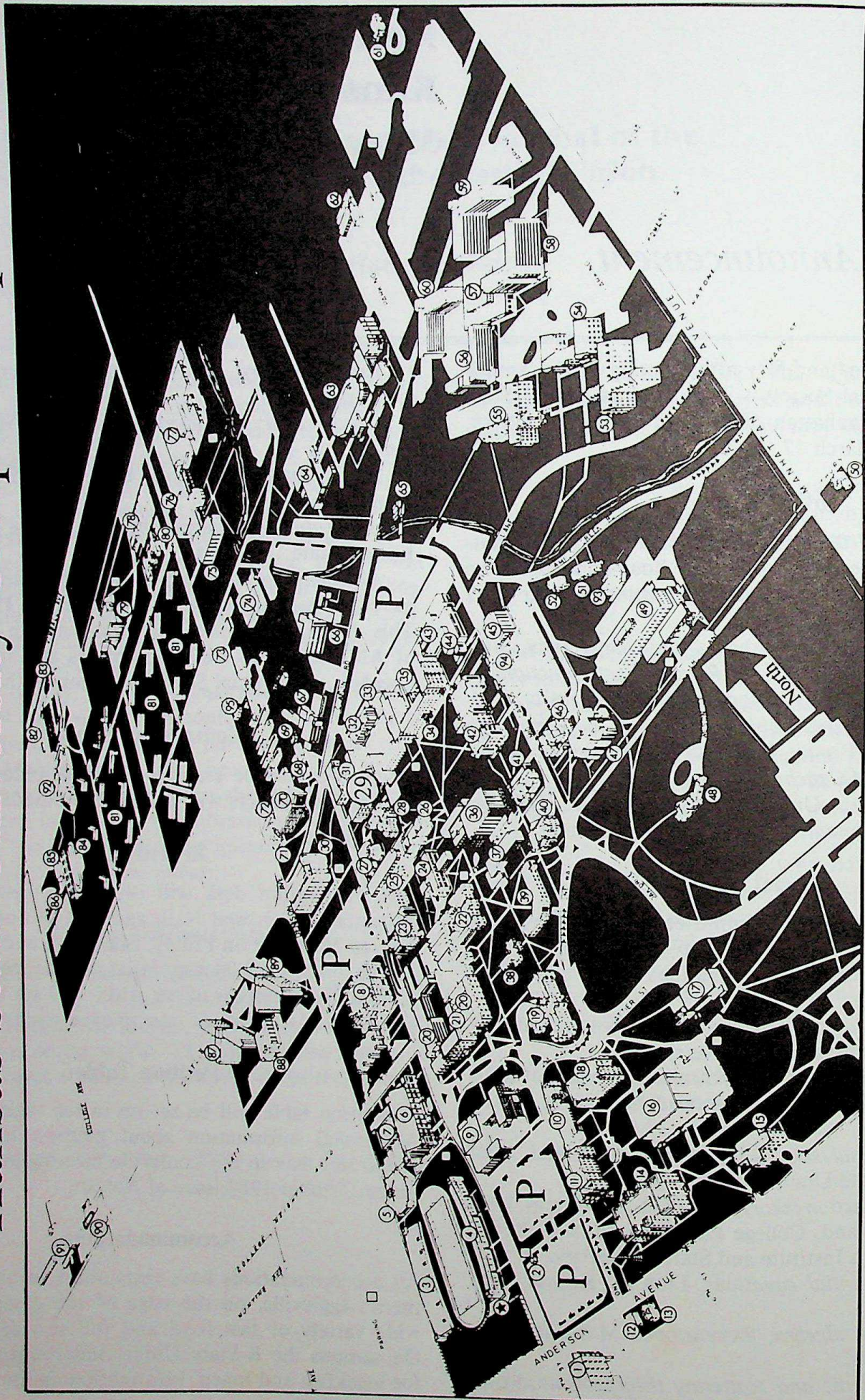
Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

Accommodations

All accommodations have restaurants in or adjacent to them. Aggieville, on the edge of the campus, offers a wide variety of fast food and full service restaurants. On campus the K-State Union Stateroom will be open for breakfast and lunch. Information on area restaurants

Kansas State University Campus Map



Parking — P

Cardwell Hall (29)

will be included in a welcome packet available at the meeting registration desk. The AMS is not responsible for rate changes or accommodations offered by hotels/motels.

All Seasons Motel

1501 Tuttle Creek Bld, Manhattan, KS 66506
Telephone: 913-539-5391

Single \$35.44 Double \$39.87

Continental Inn

100 Bluemont Ave., Manhattan, KS 66506
Telephone: 913 776-4771

1 person/1 bed \$35.28 1 person/2 beds \$37.38
2 persons/1 bed \$39.68 2 persons/2 beds \$44.10

Holiday Inn/Holidome

530 Richards Drive, Manhattan, KS 66506
Telephone: 913-539-5311

Single \$64.24 Poolside Single/Double \$70.88

Motel 6

510 Tuttle Creek, Manhattan, KS 66506
Telephone: 913-537-1022

Single \$21.95 Double \$28.61

University Inn

17th & Anderson Avenue, Manhattan, KS 66506
Telephone: 913-539-7531

Single \$38 Double \$44

These are special rates offered to participants.

Super 8

200 Tuttle Creek, Manhattan, KS 66506
Telephone: 913-527-8468

1 person/1 bed \$31.26 2 persons/1 bed \$35.59
2 persons/2 beds \$37.76

Travel

Kansas State University is located in Manhattan, eight miles north of Interstate 70, and one-hundred-and-thirty miles west of Kansas City. Flights are available to Kansas City International Airport in Kansas City, Missouri, on several major airlines with connections to the Manhattan Municipal Airport. Airport shuttle service is available to the campus at reasonable rates.

If traveling by car, participants should take Interstate 435 (south) and follow Interstate 70 (west) to State Highway 177 into Manhattan.

Parking

Parking is available on campus. A parking fee of \$2 will be charged on Friday, March 16.

Weather

A wide range of weather is possible in Kansas in March. Participants are advised to note regional forecasts near the time of the meeting.

Andy Roy Magid

Associate Secretary
Norman, Oklahoma



PARTITION PROBLEMS IN TOPOLOGY

Stevo Todorcevic

(Contemporary Mathematics, Volume 84)

This book presents results on the case of the Ramsey problem for the uncountable: When does a partition of a square of an uncountable set have an uncountable homogeneous set? This problem most frequently appears in areas of general topology, measure theory, and functional analysis. Building on his solution of one of the two most basic partition problems in general topology, the "S-space problem," the author has unified most of the existing results on the subject and made many improvements and simplifications. The first eight sections of the book require basic knowledge of naive set theory at the level of a first year graduate or advanced undergraduate student. The book may also be of interest to the exclusively set-theoretic reader, for it provides an excellent introduction to the subject of forcing axioms of set theory, such as Martin's axiom and the Proper forcing axiom.

1980 *Mathematics Subject Classifications*: 04-02, 03E05, 03E50; 50-02, 54A25

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Fayetteville, Arkansas

University of Arkansas

March 23 – 24

Second Announcement

The eight-hundred-and-fifty-sixth meeting of the American Mathematical Society will be held at the University of Arkansas in Fayetteville, Arkansas on Friday, March 23, and Saturday, March 24, 1990. This meeting will be held in conjunction with the University of Arkansas' Fourteenth Annual Lecture Series in Mathematical Sciences, and in cooperation with the Society for Industrial and Applied Mathematics. All sessions will be held in the Center for Continuing Education.

Invited Addresses

By invitation of the Southeastern Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks where available, and the scheduled times of presentation are:

MARCEL F. NEUTS, University of Arizona, *Phase-type distributions: basic properties*, 11:00 a.m. Friday. This talk is part of the University of Arkansas' Fourteenth Annual Lecture Series and is in cooperation with the Society for Industrial and Applied Mathematics. The three remaining talks in the Lecture Series will occur in the Special Session on *Probability distributions of phase type and applications*, also being held in cooperation with the Society for Industrial and Applied Mathematics.

VLADIMIR I. OLIKER, Emory University, *Selected nonlinear problems in geometry*, 1:00 p.m. Friday

MARK A. STERN, Duke University and the Institute for Advanced Study, *A geometric trace formula for Hecke operators*, 11:00 a.m. Saturday.

JONATHAN M. WAHL, University of North Carolina, Chapel Hill, *The topology of isolated complex surface singularities*, 1:00 p.m. Saturday.

Special Sessions

By invitation of the same committee, there will be nine special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Singular integral operators and related areas, GERALDO SOARES DE SOUZA and GARY SAMPSON, Auburn University, Auburn.

Banach algebras, JOHN DUNCAN, University of Arkansas.

Semigroups in geometry and analysis, KARL H. HOFMANN and JIMMIE D. LAWSON, Louisiana State University, Baton Rouge.

On complex function theory of one and several variables, DIMA KHAVINSON, University of Arkansas, Fayetteville.

Phase-type distributions and some applications, ITRE E. MONROE and COLM A. O'CONNOR, University of Arkansas, Fayetteville. The three remaining talks of the Fourteenth Lecture Series will occur during this Special Session.

Algebraic geometry, DAVID R. MORRISON, Duke University, and JONATHAN M. WAHL.

Geometry, physics, and nonlinear PDE's, VLADIMIR I. OLIKER and ANDREJS E. TREIBERGS, University of Utah.

Combinatorics, JAMES G. OXLEY, Louisiana State University.

Differential geometry, WILLIAM L. PARDON, Duke University, and MARK A. STERN.

Abstracts for consideration for these sessions should have been submitted by the **November 21, 1989** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of the *Notices*.

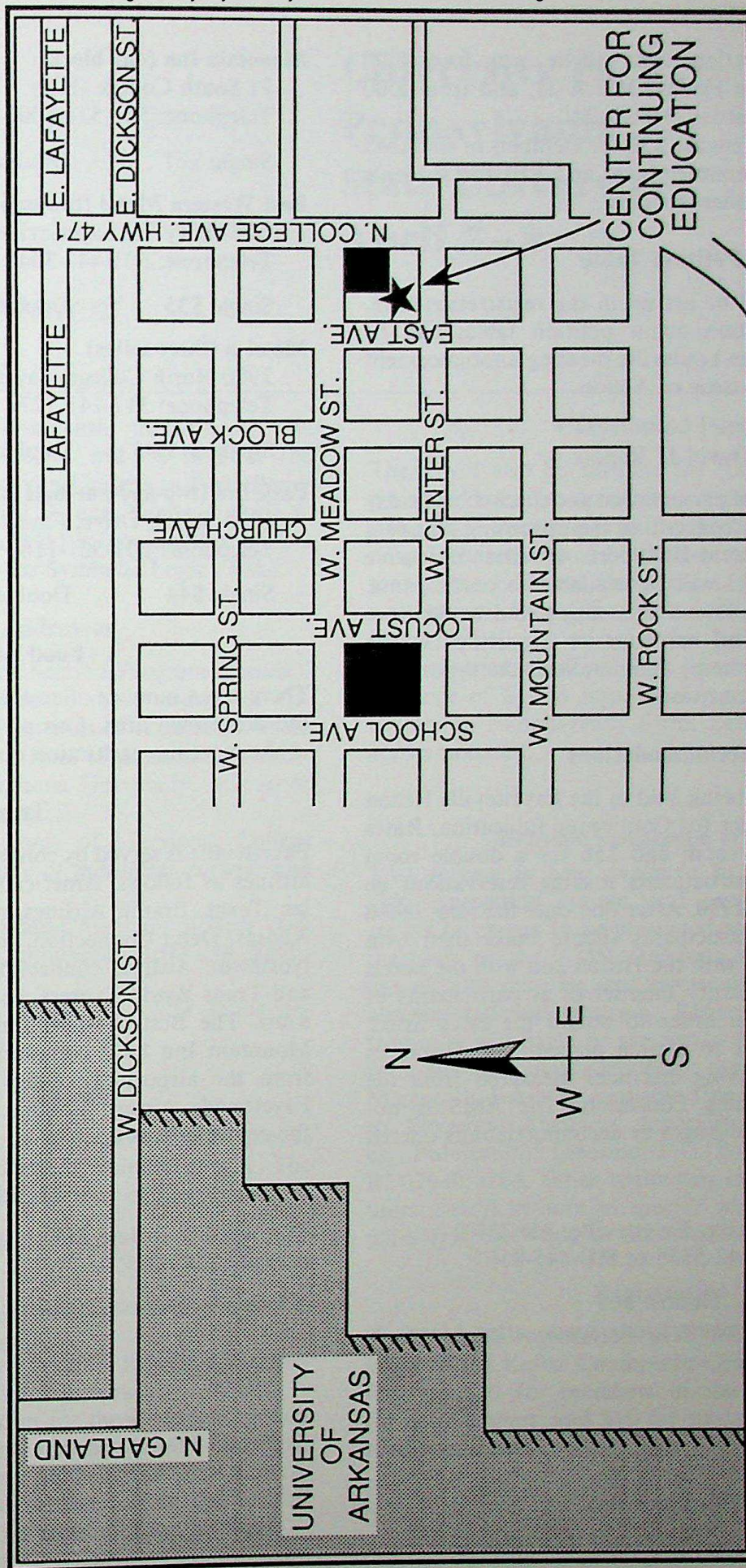
Contributed Papers

There will also be sessions for contributed ten-minute papers. Late papers will not be accommodated.

Registration

The meeting registration desk will be located on the second floor (street level) of the Center for Continuing Education located on the square in downtown Fayetteville at the corner of East Avenue and Center Street.

UNIVERSITY OF ARKANSAS



The meeting registration desk will be open from 8:00 a.m. to 5:00 p.m. on Friday, March 23, and from 8:00 a.m. to noon on Saturday, March 24.

The registration fees are \$30 for members of the AMS or SIAM, \$45 for nonmembers, and \$10 for students and unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

David II Report

There will be a special presentation and discussion Friday evening at 7:15 p.m. concerning the upcoming National Research Council David II Report. A written executive summary of David II will be available to participants. This report is to be issued this spring and could have a major impact on all mathematics departments. The focus will be on becoming familiar with the report and discussing its use in our work.

Accommodations

A block of rooms is being held in the Fayetteville Hilton adjacent to the Center for Continuing Education. Rates of \$49 for a single room and \$56 for a double room will be offered to participants making reservations **no later than March 8, 1990**. After that date the rates listed below will apply. Participants should make their own reservations directly with the Hilton and with the hotels listed below and identify themselves as participants of the AMS meeting in order to obtain the rates listed. All rates are subject to a nine percent tax. Distances given below are driving distances measured from the Center for Continuing Education. The AMS is not responsible for rate changes or accommodations offered by hotels/motels.

Fayetteville Hilton

70 North East Street, Fayetteville, AR 72701
Telephone: 501-442-5555 or 800-445-8667

Single \$58 Double \$69

Above rates for reservations made after March 8, 1990.

Mountain Inn (one block)

21 South College (Hwy. 471), Fayetteville, AR 72701
Telephone: 501-521-1000 or 800-336-7133

Single \$27 Double \$29

Best Western Motel (two-and-one-half miles)

1000 Hwy 71, Fayetteville, AR 72701
Telephone: 501-442-3041 or 800-528-1234

Single \$35 Double \$39

Motel 6 (three miles)

2980 North College, Fayetteville, AR 72701
Telephone: 317-741-7777

Single \$19.95 Double \$25.95

Park Inn (two-and-one-half miles)

1255 Shiloh Drive, Fayetteville, AR 72701
Telephone: 501-521-1166 or 800-437-7275

Single \$44 Double \$46

Food Service

There are a number of restaurants on the square and in the downtown area. Complete listings will be available at the meeting registration desk.

Travel

Fayetteville is served by commuter lines for several major airlines as follows: American Eagle, connecting in Dallas, Texas; Braniff Airlines, connecting in Kansas City, Kansas; Delta Connection, connecting in Dallas, Texas; Northwest Airlin, connecting in Memphis, Tennessee; and Trans World Express, connecting in St. Louis, Missouri. The Best Western Inn, Fayetteville Hilton, and Mountain Inn have complimentary van service to and from the airport. Taxi service is also available. The Fayetteville Airport is approximately four miles from the center of town.

Weather

The weather in late March is usually mild though it is occasionally rainy.

Joseph A. Cima
Associate Secretary
Chapel Hill, North Carolina

University Park Pennsylvania State University April 7 – 8

First Announcement

The eight-hundred-and-fifty-seventh meeting of the American Mathematical Society will be held at the Pennsylvania State University in University Park, Pennsylvania, on Saturday, April 7, and Sunday, April 8, 1990. This meeting will be held in conjunction with a meeting of the Association for Symbolic Logic (ASL).

Invited Addresses

By invitation of the Eastern Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks where available, and the scheduled times of presentation are:

ROBERT T. GLASSEY, Indiana University, *title to be announced*, 11:00 a.m. Sunday.

KARSTEN GROVE, University of Maryland, College Park, *Geometry and topology of manifolds curved from below*, 1:30 p.m. Sunday.

LOWELL EDWIN JONES, State University of New York at Stony Brook, *title to be announced*, 11:00 a.m. Saturday.

GANG TIAN, Princeton University, *title to be announced*, 1:30 p.m. Saturday.

Special Sessions

By invitation of the same committee, there will be three special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Algebraic topology, DONALD M. DAVIS, Lehigh University.

Geometric topology, THOMAS FARRELL, Columbia University.

Classical and quantum groups, RANEE KATHRYN BRYLINSKI, Pennsylvania State University.

Abstracts for consideration for these sessions should have been submitted by the **January 4, 1990** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, so as to arrive before the **January 25, 1990 abstract deadline**. Participants are reminded that a charge of \$16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Electronic Submission of Abstracts

This service is now available to those who use the T_EX typesetting system and can be used with abstracts of papers to be presented at the spring sectional meetings of the AMS. Requests to obtain the package of files may be sent electronically on Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the Abstracts package, users should be sure to specify whether they want the plain T_EX, A_MS-T_EX, or the L_AT_EX package.

Registration

The meeting registration desk will be located in the lobby of the Keller Conference Center. The registration fees are \$30 for members of the AMS or ASL, \$45 for nonmembers, and \$10 for students and unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be

found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

Activities of Other Organizations

The **Pennsylvania Prognostic Testing Conference** will be held on Friday, April 6, from 1:30 p.m. to 4:30 p.m. BERT K. WAITS, Ohio State University, will discuss the *Ohio Early Mathematics Placement Testing Program*. JOHN G. HARVEY, the University of Wisconsin, Madison, will briefly describe prognostic testing programs in the United States and discuss the effects of calculators on mathematics testing.

The **Association for Symbolic Logic (ASL)**, will have three invited one-hour addresses. The speakers are HARVEY M. FRIEDMAN, Ohio State University, Columbus; LEONARD LIPSCHITZ, Purdue University; and ATHANASIOS C. PHEIDAS, the University of Illinois at Urbana-Champaign.

The ASL and the Society will co-sponsor a symposium on *Number theory and decidability* to be moderated by BARRY MAZUR, Harvard University, and STEPHEN G. SIMPSON, Pennsylvania State University. The panelists will be SERGE LANG, Yale University, and ANGUS MACINTYRE, Oxford University.

Social Event

A wine and beer reception will be held Saturday evening, April 7, from 5:00 p.m. to 7:30 p.m. in the Fireside Lounge at the Nittany Lion Inn. The admission price is \$5 per person.

Accommodations

A block of rooms has been reserved at each of the following hotels/motels. The American Mathematical Society is not responsible for rate changes or accommodations offered by hotels/motels.

Nittany Lion Inn

North Atherton Street,
University Park, PA 16802
Telephone: 814-231-7500

Single \$58 Double \$68

Hampton Inn

East College Avenue,
University Park, PA 16802
Telephone: 814-231-1590

Single \$46 Double \$50

Sheraton/Days Inn

South Street,
University Park, PA 16802
Telephone: 814-238-8454

Single \$53 Double \$63

Food Service

The Nittany Lion Inn, adjacent to the Keller Conference Center, has a full service restaurant offering breakfast, lunch, and dinner. Complete listings will be available at the meeting registration desk.

Travel

US Air/Allegheny Commuter Airlines serve the State College area through the University Park Airport located five miles from campus. Limousine or taxi service is available for all flights. For reservations and information on US Air/Allegheny Commuter, please call 814-238-8414 or 800-428-4253. By bus, Trailways and Greyhound Lines connections are available to and from State College. For Trailways information please call 814-238-7362; for Greyhound information please call 814-237-5865. For traveling by car, University Park is readily accessible from both ends of the state via Interstate 80 (I-80).

Parking

Parking is available on campus for a fee of \$3 per day.

W. Wistar Comfort

Associate Secretary
Middletown, Connecticut

Albuquerque, New Mexico

University of New Mexico

April 19 – 21

First Announcement

The eight-hundred-and-fifty-eighth meeting of the American Mathematical Society will be held at the Sheraton Old Town Hotel in Albuquerque, New Mexico, on Thursday, April 19, Friday, April 20, and Saturday, April 21, 1990. This meeting is being held in cooperation with the Society for Industrial and Applied Mathematics and being hosted by the University of New Mexico.

Invited Addresses

By invitation of the Far Western Section Program Committee, and in cooperation with the Society for Industrial and Applied Mathematics (SIAM), there will be six invited one-hour addresses. The speakers, their affiliations, and the titles of their talks where available are:

DAVID CAMPBELL, Los Alamos National Laboratory, *Solitary waves and their interactions in non-integrable nonlinear partial differential equations*

PETER B. GILKEY, University of Oregon, *The asymptotics of the heat equation on a manifold with boundary*.

GUNDORPH K. KRISTIANSEN, Lund University, *Recent developments in time-domain inverse scattering theory using invariant embedding techniques*.

ROBERT MAY, Oxford University, *Title to be announced*.

ALAN NEWELL, the University of Arizona, *Convection patterns in large containers*.

MARC A. RIEFFEL, University of California, Berkeley, *Quantum groups and operator algebras*.

Special Sessions

By invitation of the same committee, and in cooperation with the Society for Industrial and Applied Mathematics, there will be seven special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Numerical solution of partial differential equations, RICHARD C. ALLEN, Sandia National Laboratory, JOSÉ CASTILLO, San Diego State University, and STANLY STEINBERG, the University of New Mexico.

Geometry and topology of moduli spaces, CHARLES P. BOYER, and BENJAMIN M. MANN, the University of New Mexico.

Real algebraic geometry, MICHAEL A. BUCHNER, the University of New Mexico, and WOJCIECH KUCHARZ, the University of Hawaii, and the University of New Mexico

Dynamical systems: low dimensional behavior in partial differential equations, DAVID CAMPBELL, and JAMES M. HYMAN, Los Alamos National Laboratory.

Invariant embedding and inverse problems, JAMES CORONES, Ames Laboratory, PAUL NELSON, Texas A & M, and DANIEL SETH, Ames Laboratory.

Differential geometry, HOWARD FEGAN, and ALEXANDER P. STONE, the University of New Mexico.

Mathematical Biology, JAMES M. HYMAN, Los Alamos National Laboratory, W. T. KYNER, the University of New Mexico, ANN STANLEY, Los Alamos National Laboratory, DEBORAH SULSKY, the University of New Mexico, and CARLA WOFSY, the University of New Mexico.

Abstracts for consideration for these sessions should have been submitted by the **January 4, 1990** deadline. This deadline was previously published in the Invited Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, so as to arrive before the **January 25, 1990 abstract deadline**. Participants are reminded that a charge of \$16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Electronic Submission of Abstracts

This service is now available to those who use the T_EX typesetting system and can be used with abstracts of

papers to be presented at the spring sectional meetings of the AMS. Requests to obtain the package of files may be sent electronically on Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the Abstracts package, users should be sure to specify whether they want the plain \TeX , $\text{\textit{AMS-TeX}}$, or the $\text{\textit{LAT\textsubscript{E}X}}$ package.

Council

The Council of the AMS will meet at 7:00 p.m. on Thursday, April 19, 1990, in the Fireplace Room at the Sheraton Old Town.

Poster Session

A poster session of contributed papers will be organized.

Activities of Other Organizations

The Great Plains Operator Theory Seminar will also be held at the Sheraton Old Town Hotel, April 19-21, 1990.

Registration

The meeting registration desk will be located in the lobby of the Sheraton Old Town Hotel. The meeting registration desk will be open from 6:00 p.m. to 9:00 p.m. on Wednesday, April 18, and from 8:00 a.m. to noon on Thursday, April 19, Friday, April 20, and Saturday, April 21.

The registration fee is \$45, with a special \$25 fee for graduate students and unemployed mathematicians, and a one day fee of \$25.

Social Event

On Friday evening, April 20, there will be a reception and a no-host bar at the New Mexico Museum of Natural History. During the evening participants will have exclusive access to most of the exhibits at this outstanding museum. Further information will appear in the February issue of the *Notices*.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

David II Report

There will be a special presentation and discussion at the reception Friday evening concerning the upcoming National Research Council David II Report. This report is to be issued this spring and could have a major impact on all mathematics departments. The focus will be on becoming familiar with the report and discussing its use in our work.

Accommodations

A block of rooms is being held at the Sheraton Old Town Hotel and at the Rio Grande Inn, which is within walking distance. Participants should make their own reservations directly with the hotels listed below and identify themselves as participants of the AMS and SIAM meeting in order to obtain the rates listed. Participants must make reservations 45 days in advance of the meeting to be assured of the quoted rates. The American Mathematical Society is not responsible for rate changes or accommodations offered by hotels/motels in the following list.

Sheraton Old Town Hotel

800 Rio Grande Boulevard NW, Albuquerque, NM 87104
Telephone: 505-843-6300 or 800-237-2133

Single or Double \$53

Rio Grande Inn

1015 Rio Grande Boulevard, NW Albuquerque, NM 87104
Telephone: 505-843-9500

Single \$29

Double \$32

Travel

The Albuquerque Airport is served by most airlines. Both the Sheraton Old Town and the Rio Grande Inn provide free airport shuttle service. The Albuquerque City Bus (Sun-Tran) runs from the airport through the downtown area at seven minutes after the hour, and at thirty-seven minutes after the hour. The Sun-Tran Bus number is #50. Participants may board the bus on the west side of the airport on the lower level and the fare is sixty cents one-way. Cab service is also available for approximately seven dollars one-way.

Weather and Local Attractions

April temperatures in Albuquerque are mild, although participants are advised to bring a sweater or light jacket. Nearby shopping areas may still be open at the time of the meeting. Old Town in Albuquerque, has a historic plaza, Museum of Art, Museum of Natural History, and many restaurants, shops, and galleries. Albuquerque is also home to the world's longest tramway, the Sandia Peak Tramway.

Lance W. Small
Associate Secretary
La Jolla, California

Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

Fayetteville, AK, March 1990

Marcel F. Neuts	Mark A. Stern
Vladimir I. Olikier	Jonathan M. Wahl

Manhattan, KS, March 1990

J. Brian Conrey	Jean-Pierre Rosay
Stewart B. Priddy	Jang-Mei Wu

University Park, PA, April 1990

Robert T. Glassey	Lowell Edwin Jones
Karsten Grove	Gang Tian

Albuquerque, NM, April 1990

David Campbell	Robert May
Peter B. Gilkey	Alan Newell
Gundorph K. Kristiansen	Marc A. Rieffel

Columbus, OH, August 1990

Michael G. Crandall	John Morgan
(Progress in Mathematics Lecture)	(Progress in Mathematics Lecture)
Saunders Mac Lane	Michael E. Taylor
(AMS-MAA)	

Denton, TX, November 1990

Avner D. Ash	John Leucke
Peter S. Constantin	

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

March 1990 Meeting in Fayetteville, Arkansas Southeast Section

Associate Secretary: Joseph A. Cima

Deadline for organizers: Expired

Deadline for consideration: Expired

Geraldo Soares De Souza and Gary Sampson, *Singular integral operators and related areas*

John Duncan, *Banach algebras*

Karl H. Hofmann and Jimmie D. Lawson, *Semi-groups in geometry and analysis*

Dima Khavinson, *On complex function theory of one and several variables*

Itrel E. Monroe and Colm A. O'Conneide, *Phase-type distributions and some applications*

David R. Morrison and Jonathan M. Wahl, *Algebraic geometry*

Vladimir I. Olikier and Andrejs E. Treibergs, *Geometry, physics and nonlinear PDE's*

James G. Oxley, *Combinatorics*

William L. Pardon and Mark A. Stern, *Differential geometry*

March 1990 Meeting in Manhattan, Kansas Central Section

Associate Secretary: Andy Roy Magid

Deadline for organizers: Expired

Deadline for consideration: Expired

Andrew G. Bennett, *Harmonic analysis and probability theory*

David J. Foulis and Richard J. Greechie, *Orthostructures*

Kadosa M. Halasi and Qisu Zou, *Numerical analysis*

David H. Hamilton and John F. Rossi, *Geometric function theory*

Lige Li, *Partial differential equations*

Satyagopol Mandal, *Commutative algebra*

Alexander G. Ramm, *Inverse problems and scattering theory*

Joseph M. Rosenblatt, *Ergodic theory*

Richard H. Schelp, *Graph theory*

Ernest E. Shult, *Groups and geometries*

George E. Strecker, *Applications of category theory*

April 1990 Meeting in University Park, Pennsylvania

Eastern Section

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: Expired

Ranee Kathryn Brylinski, *Classical and quantum groups*Donald M. Davis, *Algebraic topology*Thomas Farrell, *Geometric topology***April 1990 Meeting in Albuquerque, New Mexico**

Far Western Section

Associate Secretary: Lance W. Small

Deadline for organizers: Expired

Deadline for consideration: Expired

Richard C. Allen, José Castillo and Stanly Steinberg,

*Numerical solution of partial differential equations*Charles P. Boyer and Benjamin M. Mann, *Geometry and topology of moduli spaces*Michael A. Buchner and Wojciech Kucharz, *Real algebraic geometry*David Campbell and James M. Hyman, *Dynamical systems: low dimensional behavior in partial differential equations*James Corones, Paul Nelson and Daniel Seth, *Invariant embedding and inverse problems*Howard Fegan and Alexander P. Stone, *Differential geometry*James M. Hyman, W. T. Kyner, Ann Stanley, Deborah Sulsky and Carla Wofsy, *Mathematical biology***August 1990 Meeting in Columbus, Ohio**

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: April 27, 1990

Eiichi Bannai, Thomas A. Dowling, Dijen Ray-Chaudhuri and Neil Robertson, *Combinatorics*Susan Jane Colley and Gary Kennedy, *Algebraic geometry*Zita M. Divis and David Terman, *Dynamics of biological systems*S. K. Jain and S. T. Rizvi, *Ring theory*Richard J. Nowakowski, *Combinatorial games*Surinder K. Sehgal and Ronald Solomon, *Group theory***October 1990 Meeting in Amherst, Massachusetts**

Eastern Section

Associate Secretary: W. Wistar Comfort

Deadline for organizers: February 2, 1990

Deadline for consideration: July 16, 1990

November 1990 Meeting in Denton, Texas

Central Section

Associate Secretary: Andy Roy Magid

Deadline for organizers: February 15, 1990

Deadline for consideration: July 16, 1990

March 1991 Meeting in Tampa, Florida

Southeastern Section

Associate Secretary: Joseph A. Cima

Deadline for organizers: June 22, 1990

Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the PCNM from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but can be found in "Rules for Special Sessions" on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the PCNM or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the PCNM well in advance of the meeting and, in any case, at least nine (9) months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to *Notices* or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in *Notices* in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three (3) weeks before the Deadline for Abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. They are selected by the Section Program Committee. The processing of proposals for Special Sessions for Sectional Meetings is handled by the Associate Secretary for the Section who then forwards the proposals to the Section Program

Committee, which makes the final selection of the proposals. Each Invited Speaker at a Sectional Meeting is invited to organize a Special Session. Just as for national meetings, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for and organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

Send Proposals for Special Sessions to the Associate Secretaries

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)

Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
e-mail: g_small@math.ams.com
(Telephone 619-534-3590)

Central Section

Andy Roy Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
e-mail: g_magid@math.ams.com
(Telephone 405-325-2052)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
e-mail: g_comfort@math.ams.com
(Telephone 203-347-9411)

Southeastern Section

Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
e-mail: g_cima@math.ams.com
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Electronic submission of abstracts is now available to those who use the \TeX typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the Abstracts package, users should be sure to specify whether they want the plain \TeX , $\text{\textit{AMS-TeX}}$, or the $\text{\textit{LATeX}}$ package.

Number of Papers Presented Joint Authorship

Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting.

An individual may contribute only one abstract by title in any one issue of *Abstracts*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Joint Summer Research Conferences in the Mathematical Sciences

University of Massachusetts at Amherst, MA, June 7 to July 4, 1990

The 1990 Joint Summer Research Conferences in the Mathematical Sciences will be held at the University of Massachusetts at Amherst from June 7 to July 4. It is anticipated that the conferences will be supported by grants from the National Science Foundation and other agencies.

There will be six conferences in six different areas of mathematics. The topics and organizers for the conferences were selected by the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The selections were based on suggestions made by the members of the committee and individuals submitting proposals. The committee considered it important that the conferences represent diverse areas of mathematical activity, with emphasis on areas currently especially active and paid careful attention to subjects in which there is important interdisciplinary activity at present.

The conferences are similar in scientific structure to those held throughout the year at Oberwolfach. These conferences are intended to complement the Society's program of annual Summer Institutes and Summer Seminars, which have a larger attendance and are substantially broader in scope. The conferences are research conferences and are not intended to provide an entree to a field in which a participant has not already worked.

It is expected that funding will be available for a limited number of participants in each conference. Others, in addition to those funded, will be welcome, within the limitations of the facilities of the campus. In the spring a brochure will be mailed to all who are invited to attend the conferences. The brochure will include information on room and board rates, the residence and dining hall facilities, travel and local information and a housing form to use to request on-campus accommodations. Information on off-campus housing will also be included in the brochure. Participants should make their own housing and travel arrangements. Each participant will be required to pay nominal registration and social fees.

Those interested in attending one of the conferences should send the following information to the Summer Research Conference Coordinator, Meetings Department, American Mathematical Society, Post Office Box 6248, Providence, RI 02940, through electronic

mail: CAK@MATH.AMS.COM on the Internet, or by FAX: 401-331-3842.

Please type or print the following:

1. Title and dates of conference desired;
2. Full name;
3. Mailing address;
4. Telephone number and area code for office and home;
5. Member of AMS, IMS, or SIAM? If AMS, please give member code;
6. Your scientific background relevant to the topic of the conference;
7. Financial assistance requested; please estimate cost of travel;
8. Indicate if interested in attending if support is not offered. Indicate if support is not required.

Funds may also be available for foreign graduate students under the Short Term Enrichment Program (STEP) of the United States Information Agency (USIA). Students must meet the following eligibility requirements: 1. must be enrolled in full-time graduate studies at a U.S. institution of higher education; 2. are not receiving any U.S. government funds for academic support; 3. are not on refugee, immigrant, or tourist visa status; and 4. have not been awarded STEP grants previously. Those eligible should include the following information when supplying the above eight items: 1. home country; 2. student status; 3. name of institution enrolled; 4. name of an official at the institution who can verify status and financial situation.

The deadline for receipt of applications is February 23, 1990. Requests for invitations will be forwarded to the Organizing Committee for each conference for consideration after February 23. Applicants selected will receive formal invitations and notification of financial assistance from the AMS. **Requests received past the deadline will be returned.** Funds available for these conferences are limited and individuals who can obtain support from other sources should do so. Women and members of minority groups are encouraged to apply and participate in these conferences.

Any questions concerning the scientific portion of the conference should be directed to the chair or any member of the Organizing Committee.

The Joint Summer Research Conferences in the Mathematical Sciences are under the direction of the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The following committee members chose the topics for the 1990 conferences: William B. Arveson, John A. Burns, Martin Golubitsky, Daniel J. Kleitman, Anthony W. Knapp, Ingram Olkin, Mary Ellen Rudin, Stephen Simpson and Gregg J. Zuckerman.

Descriptions of the subject matter of each of the 1990 conferences appeared in the October and November *Notices*, pages 1087–1089 and 1242–1243 respectively; they were accompanied by lists of members of the respective Organizing Committees.

Thursday, June 7 to Wednesday, June 13

Probability models and statistical analysis for ranking data

MICHAEL A. FLIGNER (The Ohio State University), Co-Chair,

JOSEPH S. VERDUCCI (The Ohio State University), Co-Chair

Thursday, June 7 to Wednesday, June 13

Inverse scattering on the line

DAVID SATTINGER (University of Minnesota, Minneapolis), Chair

Thursday, June 14 to Wednesday, June 20

Deformation theory of algebras and quantization with applications to physics

MURRAY H. GERSTENHABER (University of Pennsylvania), Co-Chair

JAMES D. STASHEFF (University of North Carolina at Chapel Hill), Co-Chair

Thursday, June 21 to Wednesday, June 27

Strategies for sequential search and selection in real time

THOMAS S. FERGUSON (University of California, Los Angeles), Co-Chair

STEPHEN M. SAMUELS (Purdue University), Co-Chair

Thursday, June 21 to Wednesday, June 27

Schottky Problems

LEON EHRENPREIS (Temple University), Co-Chair

ROBERT C. GUNNING (Princeton University), Co-Chair

Thursday, June 28 to Wednesday, July 4

Logic, local fields, and subanalytic sets

LOU VAN DEN DRIES (University of Illinois at Urbana-Champaign), Chair

3-MANIFOLDS WHICH ARE END 1-MOVABLE

Matthew G. Brin and T. L. Thickstun

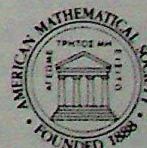
(Memoirs of the AMS, Number 411)

While requiring only the basics of 3-manifold topology as background, this book introduces recent techniques that will certainly find further application and brings readers to the frontiers of the topology of noncompact 3-manifolds.

Traditional techniques for analyzing noncompact 3-manifolds involve study of its compact subsets. By contrast, this work utilizes certain open subsets called end reductions, which are "simple" approximations to a noncompact manifold that inherit many of the manifold's properties. In this work, the authors further their development of the concept of end reduction and use it to analyze all orientable, noncompact 3-manifolds in which loops near infinity homotop to infinity while staying near infinity (this is the proper homotopy condition "end 1-movable" of the title).

The class of manifolds examined here also includes the "missing boundary" manifolds. The authors provide a new characterization of orientable, missing boundary 3-manifolds and contribute some information about the open question of determining which covers of compact 3-manifolds are missing boundary manifolds.

1980 *Mathematics Subject Classifications*: 57N10; 57M10, 57N65
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ISSN 0065-9266
73 pages (softcover), September 1989
Individual member \$9, List price \$15,
Institutional member \$12
To order, please specify MEMO/411NA



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1990 Summer Seminar in Applied Mathematics

Vortex dynamics and vortex methods

University of Washington, Seattle, June 18–29

The twenty-first AMS-SIAM Summer Seminar in Applied Mathematics will be held June 18–29, 1990, at the University of Washington, Seattle. The seminar will be sponsored jointly by the American Mathematical Society and the Society for Industrial and Applied Mathematics. It is anticipated that the seminar will be supported by a grant from federal agencies. The proceedings of the seminar will be published by the AMS in the *Lectures in Applied Mathematics* series.

The conference will feature expository lectures and advanced research talks on vorticity-dominated flows. The subjects of the talks will include numerical methods and computations, and some applied mathematical analysis and laboratory experiments. A goal of this conference is to bring together researchers with different viewpoints in order to suggest new approaches and to facilitate critical evaluations of existing techniques.

The invited speakers include J. BELL, Lawrence Livermore National Laboratories; R. CAFLISCH, University of California, Los Angeles; A. J. CHORIN, University of California, Berkeley; A. GHONIEM, Massachusetts Institute of Technology; E. HOPFINGER, Université de Grenoble; T. HOU, Courant Institute of Mathematical Sciences, New York University; H.-O. KREISS, University of California, Los Angeles; A. MAJDA, Princeton University; T. MAXWORTHY, University of Southern California; J. NEU, University of California, Berkeley; S. ORSZAG, Princeton University; P. SAFFMAN, California Institute of Technology; and N. ZABUSKY, University of Pittsburgh.

The Organizing Committee consists of CHRISTOPHER R. ANDERSON, University of California, Los Angeles, co-chair; STEPHEN CHILDRESS, Courant Institute of Mathematical Sciences, New York University; GEORGE-HENRI COTTET, University of California, Los Angeles and Ecole Polytechnique, Paris; CLAUDE GREENGARD, IBM T.J. Watson Research Center, co-chair; and ANTHONY LEONARD, California Institute of Technology.

A brochure will be available from the AMS office which will include a description of the scientific program, information on accommodations, and local information. Participants will be required to pay a \$20 registration fee and a nominal social fee.

Those interested in attending the seminar should send the following information to the Summer Seminar Conference Coordinator, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, by electronic mail BAV@MATH.AMS.COM, or by FAX: 401-331-3842 before March 23, 1990.

Please type or print the following:

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home; E-mail address (if applicable);
4. Member of AMS or SIAM? Include customer code if an AMS member;
5. Anticipated arrival and departure dates;
6. Your scientific background relevant to the topic of the seminar;
7. Financial assistance requested (please estimate cost of travel);
8. Indicate if interested in attending if support is not offered. Indicate if support is not required.

Participants who wish to apply for a grant-in-aid should so indicate; however, funds available for the seminar are very limited and individuals who can obtain support from other sources should do so. Graduate students who have completed at least one year of graduate school are encouraged to participate.

Funds may also be available for foreign graduate students under the Short Term Enrichment Program (STEP) of the United States Information Agency (USIA). Students must meet the following eligibility requirements: 1. must be enrolled in full-time graduate studies at a U.S. institution of higher education; 2. are not receiving any U.S. government funds for academic support; 3. are not on refugee, immigrant, or tourist visa status; and 4. have not been awarded STEP grants previously. Those eligible should include the following information when supplying the above eight items: 1. home country; 2. student status; 3. name of institution enrolled; 4. name of an official at the institution who can verify status and financial situation.

1990 Summer Research Institute

Differential Geometry

University of California, Los Angeles, July 8 – 28

The thirty-eighth Summer Research Institute sponsored by the American Mathematical Society will be devoted to *Differential Geometry* and will take place at the University of California, Los Angeles. Members of the Organizing Committee are: ROBERT BRYANT, Duke University; EUGENIO CALABI, University of Pennsylvania; S. Y. CHENG, University of California, Los Angeles; H. BLAINE LAWSON, State University of New York, Stony Brook; H. WU, University of California, Berkeley; ROBERT E. GREENE, University of California, Los Angeles (co-chair); and S. T. YAU, Harvard University (co-chair).

It is anticipated that the institute will be partially supported by a grant from the National Science Foundation. Proceedings of the institute will be published in the AMS series *Proceedings of Symposia in Pure Mathematics*.

This topic was selected by the 1988 AMS Committee on Summer Institutes and Special Symposia whose members at the time were: STEVEN L. KLEIMAN (chair), HAYNES R. MILLER, RAGHAVAN NARASIMHAN, PAUL H. RABINOWITZ, THOMAS C. SPENCER, and ROBERT B. WARFIELD, JR..

The years since the last AMS Summer Institute on differential geometry, held in 1973, have been a period of explosive growth and exciting research in this subject. Seen in retrospect, the 1973 institute both recounted the accomplishments in geometry in the 1960's and early 1970's and at the same time marked some new directions for the field. Riemannian geometry in the purest sense along with the theory of characteristic classes in geometry were enjoying a triumphant period. The previous decade had seen the quarter-pinching Sphere Theorem results, on complete open manifolds of nonnegative curvature, the use of heat kernel asymptotics in invariant theory, the discovery of new invariants, and the rapid growth of the theory of foliations. The 1973 institute also heralded a new era just beginning: work on prescribed curvature, the renewed interest in the spectrum of the Laplacian, and the beginning of the study of complex manifolds using analytic $\bar{\partial}$ methods. These were all portents of a new growth period which would involve a vast increase in the use of partial differential equations in geometry.

Partial differential equations arise naturally in geometry. The association of curvature tensor to metric is itself a partial differential operator, which could be thought of as the central object of the whole subject.

Many other operators also arise naturally, as the Euler-Lagrange equations for variational problems. Naturally arising variational problems yield the minimal submanifold equations, the equations for harmonic maps, the complex Monge-Ampere equation for the Ricci curvature of a Kähler manifold, and the Yang-Mills equations. Since the early 1970's, significant progress has been made in understanding all these partial differential equations and many others on manifolds. In a virtually unprecedented way, it has become possible to approach the problems of geometry by direct study of the relevant partial differential equations. The results have transformed the subject of differential geometry.

Any reasonably short list of specific theorems will be necessarily partial, so numerous are the results, but some highlights will help to indicate the magnitude of the progress made: the solution of the Calabi Conjecture on the existence of canonical Einstein-Kähler metrics; the related constructions of a canonical complete Einstein-Kähler metric on pseudoconvex domains in C^n ; the solution of the positive mass conjecture of relativity; the classification of manifolds of positive scalar curvature; results on minimal surfaces in 3-manifolds which were instrumental in the proof of the Smith Conjecture; the use of harmonic maps to prove rigidity theorems for complex manifolds; the characterization of C^n by curvature and related results on gap phenomena for Riemannian manifolds; the development of harmonic function theory on manifolds; the construction of surfaces of constant mean curvature; new results on differential systems; the determination of the possible holonomy groups; the solution of the Frankel conjecture on compact Kähler manifolds of nonnegative bisectional curvature; the solution of the Yamabe problem; the deformation of manifolds of positive Ricci curvature to constant positive; and the existence of canonical metrics on stable vector bundles.

Special mention should be made of the spectacular geometric results arising from Yang-Mills theory. Yang-Mills theory is again an example of an extremal problem, in this case in effect the minimization of the square integral of the curvature of a connection on a principal bundle. When the bundle lies over a 4-dimensional manifold, an additional structural feature arises in that the Hodge star takes the curvature 2-form again to a 2-form, so that 2-forms can be symmetrized and an-

tisymmetrized relative to this operation. Out of this rich geometric structure arises the possibility of proving profound differential topological results on 4-manifolds by geometric methods. The most spectacular of these is perhaps the existence of "exotic" (nonstandard) differentiable structures on topological R^4 .

There have also been revolutionary developments in Riemannian geometry outside the partial differential equations methods. New concepts and methods involving the limiting behavior of metrics and the structure of the space of Riemannian manifolds as a whole has given new life to manifold geometry. Highlights include: the characterization of almost flat manifolds; the bounds on the Betti numbers of manifolds of nonnegative curvature; finiteness and convergence theorems for manifolds satisfying curvature bounds; and a comprehensive theory of manifolds of negative curvature.

The general intention for the 1990 Summer Institute is to cover not only developments in differential geometry itself, but also related topics in other parts of mathematics and in physics. The planned format is to have a number of one hour survey lectures in the morning sessions offering more broadly sketched viewpoints, followed in the afternoons by shorter, more specialized seminar lectures in parallel sessions. For organizational purposes the subject will be divided into eight subdivisions: Riemannian geometry; minimal submanifolds; complex geometry and L^2 cohomology; general theory of partial differential equations on manifolds - harmonic functions and mappings, Monge-Ampere equation, differential systems, and isometric embedding; eigenvalues, heat flow, and index theory; gauge theory and geometry in mathematical physics; groups and manifolds, and dynamical systems; and symplectic geometry.

While it is anticipated that seminar activity on all these topics will continue throughout the three weeks of the institute, each week will have a different specific emphasis on two or more of the eight topics. Further details, along with the names of the survey lecturers will be provided in a later announcement.

Accommodations will be available in the campus residence halls for participants; cafeteria style meals will be available. All facilities will be accessible to the handicapped.

Information on housing, dining, travel and the local area will be sent to invited participants in the spring. Each participant will pay a registration fee and a social fee to cover the costs of social events scheduled during the institute.

Those interested in receiving an invitation to participate in the institute should send the following information to the Summer Institute Conference Coordinator, American Mathematical Society, Post Office Box 6248, Providence, RI 02940, **prior to April 1, 1990** or through electronic mail: WSD@MATH.AMS.COM, or by FAX 401-331-3842.

Please type or print the following:

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Which week or weeks you wish to attend;
5. Your scientific background relevant to the institute topic;
6. Financial assistance requested;
7. Indicate if interested in attending if support is not offered. Indicate if support is not required.
8. If member of AMS, give AMS member code.

Funds may also be available for foreign graduate students under the Short Term Enrichment Program (STEP) of the United States Information Agency (USIA). Students must meet the following eligibility requirements:

1. must be enrolled in full-time graduate studies at a U.S. institution of higher education;
2. are not receiving any U.S. government funds for academic support;
3. are not on refugee, immigrant, or tourist visa status; and
4. have not been awarded STEP grants previously. Those eligible should include the following information when supplying the above eight items: 1. home country; 2. student status; 3. name of institution enrolled; 4. name of an official at the institution who can verify status and financial situation.

Requests for invitations will be forwarded to the Organizing Committee for consideration up to the deadline of April 1, and applicants selected will receive formal invitations and notification of financial assistance beginning in mid-May.

Mathematics Sessions at the AAAS Annual Meeting

New Orleans, Louisiana, February 15-20, 1990

The 1990 Annual Meeting of the AAAS, February 15-20 in New Orleans, will feature many outstanding expository talks by prominent mathematicians. These include the following symposia (three-hour sessions) and invited talks cosponsored by Section A (Mathematics) of the AAAS and the Society. The names and affiliations of the organizers follow (speakers' names are given in parentheses):

- *Radon and Penrose transforms: Medical imaging to supersymmetry*, organized by JAMES V. PETERS, Long Island University, C.W. Post Center, and TODD QUINTO, Tufts University. (Allan Cormack, Gabor Herman, Larry Shepp, Ron O. Wells)
- *New directions in the philosophy of mathematics*, organized by REUBEN HERSH, University of New Mexico. (Gian-Carlo Rota, Thomas Tymoczko, Nicholas Goodman, Hao Wang, Martin Krieger, Michael Resnik)
- *Computational and mathematical modeling: A study of oil production and water resources*, organized by JAMES G. GLIMM, New York University. (James Glimm, Richard Ewing, Brent Lindquist, Larry Lake, David Wilkinson)
- *Geometry today*, organized by ERWIN LUTWAK, Polytechnic University of New York, and RALPH ALEXANDER, University of Illinois at Urbana. (George Francis, Vladimir Olikier, Herman Gluck, Gian-Carlo Rota)
- *Zero knowledge proofs and their applications*, organized by SILVIO MICALI, Massachusetts Institute of Technology. (Shafi Goldwasser, Manuel Blum, Silvio Micali)

- *Frontiers of physical sciences: A mathematics lecture* by FRANK MORGAN, Williams College.

- *One day short course on Chaotic dynamical systems* by ROBERT L. DEVANEY, Boston University.

Section A of the AAAS is also cosponsoring various symposia that will be of interest to mathematicians and mathematics educators. These include:

- *Chaos in the balance of nature*
- *Symmetry: Its theory and application through science*
- *Mathematical models in the social sciences*
- *The contributions of R.A. Fisher to science* (symposium commemorating the centennial of R.A. Fisher's birthday)
- *Revitalizing science and mathematics education through the use of technology*
- *Project approaches in developing new introductory physics, chemistry, and mathematics curricula*
- *The development of pre-adult attitudes toward science and mathematics in Japan and the United States.*

A meeting of the Section A Committee will take place from 4:00 p.m. to 6:00 p.m. on February 15 in Marlborough B Room of the New Orleans Hilton. The committee meeting is open to all who wish to stimulate interest and activities of the mathematical sciences within the AAAS.

For details see the November 10, 1989, issue of *Science*. Additional information on Section A activities can be found in the *News and Announcements* section of the November 1989 issue of *Notices*.

Mathematical Sciences Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

EFFECTIVE with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.

1989-1990. **Academic Year Devoted to Hyperbolic Geometry and Quasiconformal Mappings**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1988, p. 1584)

1989-1990. **Special Year in Geometry**, University of Maryland, College Park, MD. (Dec. 1989, p. 1432)

1990. **IMACS International Workshop on Massively Parallel Methods in Com-**

putational Physics, Boulder, Colorado. (Sep. 1989, p. 914)

1990. **IMACS Conference on Computer Aided Design**, Yugoslavia. (Sep. 1989, p. 914)

1990-1991. **Academic Year Devoted to Operator Theory and Complex Analysis**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1989, p. 1432)

January 1990

28-February 3. **Regelungstheorie**, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 314)

29-February 16. **Second College on Variational Problems in Analysis**, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 600)

February 1990

1-4. **Topological and Measurable Dynamics**, Minneapolis, MN. (Nov. 1988, p. 1247)

* 3. **Eighty-seventh Ontario Mathematics Meeting**, Ottawa, Ontario, Canada. (Please note changes from Oct. 1988, p. 1094)

INVITED SPEAKERS: P. March, Ohio State University; N.J.A. Sloane, Bell Laboratories; W.P. Thurston, Princeton University.

4-10. **Funktionstheoretische Methoden Bei Partiellen Differential Und Integralgleichungen**, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 314)

4-10. **Nukleare Frechet-Räume**, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 314)

5-10. **Eighth International Seminar on Model Optimization in Exploration Geophysics, with a Workshop on Geophysical Data Inversion in Environmental Research and Planning**, Berlin-West, Free University of Berlin, Federal Republic of Germany. (Jul./Aug. 1989, p. 765)

11-15. **The Twenty-sixth Australian Applied Mathematics Conference**, Coolangubatta, Queensland, Australia. (Sep. 1988, p. 915)

11-17. **Funktionstheorie**, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

12-16. **Southeastern International Conference on Combinatorics, Graph Theory and Computing**, Florida Atlantic University, Boca Raton, FL. (Dec. 1988, p. 1433)

* 12-16. **Internationaler Workshop Komplexer Analysis**, Wuppertal, Federal Republic of Germany.

ORGANIZERS: K. Diederich, Wuppertal; J.E. Fornæss, Princeton; I. Liebmann, Bonn.

INFORMATION: Workshop Komplexe Analysis, Frau D. Lindner, Mathematik, Universität-GHS Wuppertal, Gaußstr. 20, D-5600 Wuppertal 1.

15-20. American Association for the Advancement of Science Annual Meeting, New Orleans, LA. (Nov. 1989, p. 1248)

17-19. Algebraic Geometry and Group Theory Conference/Inaugural Meeting of the Ulam Quarterly, West Palm Beach, Florida. (Nov. 1989, p. 1248)

18-24. Mathematische Modelle in Der Biologie, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

20-22. Association for Computing Machinery 1990 Computer Science Conference, Washington, D.C. (May/Jun. 1989, p. 601)

22-23. Twenty-first SIGCSE Technical Symposium, Washington, D.C. (May/Jun. 1989, p. 601)

23-24. Second Annual Southeast Dynamical Systems Conference, University of South Alabama, Mobile, AL.

INVITED SPEAKERS: L. Block, F. Botelho, R. Fox, J. Franks, D. Fried, J. Hawkins, J. Milnor, S. Newhouse, K. Palmer.

INFORMATION: S. Williams, Dept. of Math. and Stat., Univ. of South Alabama, Mobile, AL 36688; 205-460-6264; email: f0dm@usouthal.bitnet.

25-26. Conference on Approximation Theory and Functional Analysis (in honor of Professor George Lorentz on the occasion of his 80th birthday), Texas A&M University, College Station, TX 77843.

INFORMATION: Contact Charles Chui at Bitnet: e443cc@tamvml.

25-March 3. Eigenwertaufgaben In Natur Und Ingenieurwissenschaften Und Ihre Numerische Behandlung, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

26-27. Workshop on Asymptotic Analysis and Numerical Solution of PDEs, Argonne, Illinois.

INFORMATION: H.G. Kaper, Mathematics and Computer Science Division, Argonne National Laboratory, 312-972-7162; email: aawrkshp@mcs.anl.gov.

26-March 2. IEEE Computer Society COMPCON Spring '90, San Francisco, CA. (Sep. 1989, p. 915)

March 1990

1-4. Mathematicians and Education Reform Network, Ohio State University, Columbus, Ohio. (Nov. 1989, p. 1248)

4-10. Interval Methods for Numerical Computation, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

5-7. SIAM Conference on Applied Probability in Science and Engineering, New Orleans, LA. (Nov. 1988, p. 1389)

5-7. Symposium on Symbolic Computation (on the occasion of the sixtieth birthday of Erwin Engeler), Zürich, Switzerland. (Sep. 1989, p. 915)

* 5-9. Bifurcations Dynamiques, Marseille, France.

CHAIRMEN: M.M. Candelpergher; Loby, Nice; Benoit, Antipolis.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

11-17. Mathematische Stochastik, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

12-16. Twist Mappings and Their Applications, Minneapolis, MN. (Nov. 1989, p. 1248)

13-16. Twenty-first Annual Iranian Mathematics Conference, University of Isfahan, Iran. (Jul./Aug. 1989, p. 766)

14-19. East European Category Seminar, Predela, Bulgaria. (May/Jun. 1989, p. 601)

15-21. International Conference on Differential Equations and Mathematical Physics, University of Alabama at Birmingham, Alabama. (Oct. 1989, p. 1094)

16-17. Central Section Meeting of the AMS, Kansas State University, Manhattan, KS.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

16-18. Conference on Stochastic Flows, University of North Carolina at Charlotte, NC. (Dec. 1989, p. 1434)

18-24. Masstheorie, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

18-24. Third Centenary Celebration of the Mathematische Gesellschaft in Ham-

burg, Bundesstraße, Hamburg. (Oct. 1989, p. 1094)

19-22. Eleventh Annual National Graphics Association Conference and Exposition, Anaheim, CA. (Jul./Aug. 1989, p. 766)

19-24. US-USSR Approximation Theory Conference, University of South Florida, Tampa, FL. (Jul./Aug. 1989, p. 766)

19-April 13. Mathematical Physiology and Differential-Delay Equations, Minneapolis, MN. (Nov. 1989, p. 1248)

20-23. Directions in Matrix Theory, Auburn, AL. (May/Jun. 1989, p. 601)

23-24. Southeastern Section Meeting of the AMS, University of Arkansas, Fayetteville, AR.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

23-24. University of Arkansas' Fourteenth Annual Lecture Series in Mathematical Sciences, Univ. of Arkansas, Fayetteville, Arkansas. (Oct. 1989, p. 1095)

25-31. Kontinuumsmechanik der Festen Körper, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

26-29. Workshop on Number Theory and Algorithms, Berkeley, CA. (Sep. 1989, p. 916)

26-April 6. Workshop on Group Theory from a Geometrical Viewpoint, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 601)

28-29. Chaos in Praxis: The Application of Nonlinear Dynamics in Social Realms, Battelle Conference Center, Seattle, WA. (Nov. 1989, p. 1249)

29-31. Modern Perspectives of Mathematics: Mathematics in Academia, Mathematics as a Consumer Good, Cornell University, Ithaca, NY. (Nov. 1989, p. 1249)

* 30-31. Illinois Number Theory Conference, Urbana, IL.

INVITED SPEAKERS: G.E. Andrews, Penn. State Univ.; B. Conrey, Oklahoma State Univ.; A. Ghosh, Oklahoma State Univ.; A. Sárközy, Hungarian Academy of Science.

INFORMATION: B. Berndt, Dept. of Mathematics, Univ. of Illinois, Urbana IL 61801; email: berndt@symcom.math.uiuc.edu.

April 1990

- * 1-3. **Low Dimensional Dynamics**, University of Maryland at College Park.

INVITED SPEAKERS: J. Guckenheimer, A. Katok, M. Levi, S. Newhouse, R. Williams, M. Jakobson, J. Yorke, L. Young.

INFORMATION: M. Boyle or M. Jakobson, Dept. of Mathematics, University of Maryland, College Park MD 20742; email: mmb@rachel.umd.edu or mvvy@lakisis.umd.edu.

- 1-4. **ENAR Spring Meeting**, Baltimore, MD. (Jul./Aug. 1989, p. 766)

- 1-7. **Design and Codes**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- 1-14. **NATO Advanced Study Institute on "Generators and Relations in Groups and Geometries"**, Castelvechio Pascoli (Lucca), Italy. (Sep. 1989, p. 916)

- * 3-4. **Mathematics in a Changing Culture**, Glasgow College, Glasgow, Scotland.

PURPOSE: Mathematics education is facing the challenge of dealing effectively with the problems arising from the widening of student access, the problem of providing education and training relevant not only to the needs of today but to the expected needs of tomorrow. The conference aims to address these problems as they affect the teaching of mathematics, statistics and operational research in all types and levels of courses.

INFORMATION: S. McAllister, Conference Secretary, Dept. of Mathematics, Glasgow College, Cowcaddens Rd., Glasgow G4 0BA; phone 041 332 7090 ext. 336; email: mat.mcallister@uk.ac.glasg.

- * 3-5. **Forty-second British Mathematical Colloquium**, University of East Anglia, Norwich, Norfolk, England.

INVITED SPEAKERS: W. Feit, Yale; R. Graham, Bell Labs; S.J. Taylor, Virginia; G. Ellis, Galway; M. Prest, Manchester; A. Chetwynd, Lancaster; S. Bullett, QMC; R. Plymen, Manchester; N. Stephens, Cardiff; S. Donkin, QMC; M. Barlow, Cambridge; J. Gray, Open; D. Benson, Oxford; P. Kropholler, QMC; W. Chen, Imperial; H.

Halberstam, Illinois; A. May, INMOS Ltd; A. Wilkie, Oxford.

INFORMATION: 42nd BMC, School of Mathematics, University of East Anglia, Norwich, Norfolk NR4 7TJ.

- 4-7. **Symposium on Distributions with Given Marginals (In Memory of Giuseppe Pompilj)**, Rome, Italy. (Oct. 1989, p. 1095)

- 5-7. **Twenty-fourth Annual Spring Topology Conference**, Southwest Texas State Univ., San Marcos, TX. (Nov. 1989, p. 1249)

- * 5-8. **Conference on Algebraic K-theory and Algebraic Number Theory**, Johns Hopkins Univ., Baltimore, MD.

INFORMATION: JAMI, Mathematics Department, The Johns Hopkins University, Baltimore, MD 21218; 301-338-7399.

- 7-8. **Eastern Section Meeting of the AMS**, Pennsylvania State University, University Park, PA. (Note change in date from Oct. 1989, p. 1095)

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

- 7-8. **1990 Association for Symbolic Logic Spring Meeting (in conjunction with a Spring meeting of the AMS and a MAMLS meeting)**, Pennsylvania State University, University Park, PA. (Nov. 1989, p. 1249)

- * 8-12. **Gamm-Jahrestagung**, Hannover, Federal Republic of Germany.

INFORMATION: E. Stein, Univ. Hannover, Appelstr. 9A, D-3000 Hannover 1.

- 8-14. **Arbeitsgemeinschaft Mit Aktuellem Thema (wird in den Mitteilungen der DMV Heft 1/1990 bekanntgegeben)**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- 9-13. **Fifth Workshop on Mathematical Aspects of Computer Science**, Magdeburg, German Democratic Republic. (Nov. 1989, p. 1249)

- 15-21. **Mathematical Concepts of Dependable Systems**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- * 17-21. **Phenomenes de Stokes et Resurgence**, Marseille, France.

CHAIRMEN: J. Martinet, J.P. Ramis.

INFORMATION: A. Zeller-Meier, CIR Luminy, Case 916, F-13288 Marseille Cedex 9.

- 18-21. **Sixty-eighth Annual Meeting of the National Council of Teachers of Mathematics**, Salt Lake City, UT. (Jul./Aug. 1989, p. 766)

- 19-21. **Fourth National Conference on Undergraduate Research**, Union College, Schenectady, NY. (Nov. 1989, p. 1249)

- 19-21. **Conference on Function Spaces**, Southern Illinois University, Edwardsville, IL. (Dec. 1989, p. 1435)

- 19-22. **1990 Far Western Section**, University of New Mexico, Albuquerque, New Mexico.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

- * 22-25. **Directions for the Decade in SUPERcomputing**, University of Florida, Gainesville, FL.

INFORMATION: S. Trickey or K. Pace, College of Liberal Arts and Sciences, 2014 Turlington Hall, Univ. of Florida, Gainesville, FL 32611-2036; email: super@nervm.bitnet.

- 22-27. **Tenth Conference on Analytic Functions**, Kozubnik, Poland. (Oct. 1989, p. 1095)

- 22-28. **Einhollende Algebren und Ring Von Differentialoperatoren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- 28-29. **Symposium on Value Distribution Theory in Several Complex Variables**, Univ. of Notre Dame, Notre Dame, Indiana. (Nov. 1989, p. 1250)

- 29-May 5. **Gruppentheorie (Pro-Endliche Gruppen)**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- * 30-May 4. **Mathematiques pour la Robotique**, Marseille, France.

CHAIRMEN: J.-J. Risler, Paris; A. Gligo, Nice.

INFORMATION: A. Zeller-Meier, CIR Luminy, Case 916, F-13288 Marseille Cedex 9.

May 1990

- 3-4. **Twenty-first Annual Pittsburgh Conference on Modeling and Simulation**, University of Pittsburgh, Pittsburgh, PA. (Sep. 1989, p. 916)

* 5-6. **Pacific Northwest Geometry Seminar**, University of Oregon, Eugene, OR.

INVITED SPEAKERS: J. Dupont, C. Gordon, L. Simon, W. Thurston.
INFORMATION: P. Gilkey (gilkey@bright.math.uoregon.edu) or J. Leahy.

6-9. **Computer Algebra and Differential Equations (CADE-90)**, Cornell University, Ithaca, NY. (Dec. 1989, p. 1435)

6-12. **Geschichte der Mathematik**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

7-9. **1990 IEEE Symposium on Research in Security and Privacy**, Oakland, CA. (Oct. 1989, p. 1095)

7-10. **SIAM Conference on Applications of Dynamical Systems**, Orlando, FL. (Sep. 1989, p. 916)

* 7-11. **Recent Advances in Regression**, Montréal, Canada.

ORGANIZING COMMITTEE: M. Bilo-deau, G. Ducharme, C. Léger, Y. Lepage, S. Tardif, Y. Yatracos (Coordinator).

INVITED SPEAKERS: L. Brown, Cornell Univ.; R.D. Cook, Univ. of Minnesota; C.E. Särndal, Univ. of Montréal; R. Carroll, Texas A&M Univ.; K.-C. Li, U.C.L.A.; S. Weisberg, Univ. of Minnesota.

CONFERENCE TOPICS: Nonparametric regression, diagnostics: influence and dynamic graphics, slicing inverse regression, generalized nonlinear measurement error models, regression estimators and regression analysis in survey sampling.

CALL FOR PAPERS: Papers can be presented in either of two formats: a 15 minute talk or a poster presentation. Deadline for submission for titles, abstracts (between 100 and 200 words) and financial assistance is February 15, 1990. (Specify 15 minute talks or presentation.)

INFORMATION: S. Chênevert, CRM, Université de Montréal, C.P. 6128-A, Montréal, (Quebec), Canada, H3C 3J7, 514-343-7501, Fax: 514-343-2254, email: crm@cc.umontreal.ca.

* 7-11. **Algorithmes et Programmation**, Marseille, France.

CHAIRMAN: D. Monasse, Paris.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

7-June 1. **College on Recent Developments and Applications in Mathematics and Computer Science**, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 601)

9-12. **Computer Algebra and Parallelism (CAP-90)**, Cornell University, Ithaca, NY. (Dec. 1989, p. 1435)

13-19. **Abstrakte Konvexe Analysis**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

* 14-15. **Regional Workshop on Nonlinear Conservation Laws**, Stony Brook, NY.

PURPOSE: The workshop is the first of a series concerning the theory, computation, and engineering applications of nonlinear systems of partial differential equations representing conservation laws.

PROGRAM: The workshop will consist of one-hour invited lectures describing current research of broad interest. INVITED SPEAKERS: T.-P. Liu, C.F. Palmeira.

CALL FOR PAPERS: To give a short talk, please contact the organizers and send a summary before February 28, 1990.

INFORMATION: J. Glimm, D. Marchesin, B. Plohr, Dept. of Applied Math. and Stat., State University of New York at Stony Brook, Stony Brook, NY 11794-3600; 516-632-8552; email: marchesin@chaos.sunysb.edu.

14-18. **Conference on Nonlinear Analysis and Partial Differential Equations**, Rutgers University, New Brunswick, NJ. (Jul./Aug. 1989, p. 767)

* 14-18. **Workshop on K-Theory**, Mathematical Sciences Research Institute, Berkeley, CA.

PROGRAM: This is the last of three workshops planned as part of MSRI's yearlong 1989-1990 program on Algebraic Topology and its applications. ORGANIZERS: W.-C. Hsiang, J.D.S. Jones.

INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, CA 94720.

* 14-18. **Singularités et Théorie de Hodge**, Marseille, France.

CHAIRMEN: C. Sabbath, Palaiseau; D. Barlet, Nancy.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

17-19. **Interface '90 (formerly Computer Science and Statistics: Symposium on Interface)**, East Lansing, MI. (Sep. 1989, p. 916)

17-19. **Colloquium: Computer Graphics in Pure Mathematics**, University of Iowa, Iowa City, IA. (Dec. 1989, p. 1435)

* 20-25. **NSF/CBMS Conference on Operator Algebras**, Texas Christian University, Fort Worth, TX.

PROGRAM: P.S. Muhly will present a series of ten lectures under the title: "Coordinates in Operator Algebra: Groupoids and Categories, their Representations and Applications". Additional lectures will be presented by participants as time permits.

ORGANIZER: R.S. Doran.

INVITED SPEAKER: P.S. Muhly.

INFORMATION: R.S. Doran, Dept. of Mathematics, Texas Christian University, Fort Worth, TX 76129; 817-921-7335.

20-26. **The Schrödinger Equation and Its Classical Counterparts**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

21-24. **The Simulation of Random Processes and Fields - Mathematics and Applications**, Portofino, Italy. (Sep. 1989, p. 916)

* 21-25. **NSF-CBMS Regional Conference on The Interface between Analytic Number Theory and Harmonic Analysis**, Manhattan, KS.

PROGRAM: H. Montgomery will deliver ten lectures discussing the recent research in topics pertaining to the conference title. The lectures will be accessible to both analysts and number theorists.

INVITED SPEAKERS: H.L. Montgomery, (Principle Lecturer), J. Beck, P.X. Gallagher, H. Iwaniec, T.W. Körner, J.-F. Mela, I.Z. Ruzsa, G. Tenenbaum, R.C. Vaughan.

INFORMATION: T. Cochrane or R.E. Dressler, Dept. of Mathematics, Kansas State University, Manhattan, KS 66506, 913-532-6750; email: cochrane@ksuvm.ksu.edu.

21-25. **Eleventh United States National Congress of Applied Mechanics**, Tucson, AZ. (Nov. 1988, p. 1389)

*21-25. **Nonlinear Analysis, Function Spaces and Applications IV**, Czechoslovakia.

INVITED SPEAKERS: J. García-Cuerva, Madrid; H.P. Heinig, Hamilton; V. Mustonen, Oulu; G.F. Roach, Glasgow; A. Torchinsky, Bloomington; S.K. Vodopyanov, Novosibirsk.

INFORMATION: Math. Inst. Czech. Acad. Sci., Zitná 25, 115 67 Praha 1, Czechoslovakia.

23-25. **1990 International Symposium on Multiple-Valued Logic**, Charlotte, NC. (Apr. 1989, p. 496)

24-25. **Twelfth Symposium on Mathematical Programming with Data Perturbations**, George Washington Univ., Washington, DC. (Nov. 1989, p. 1250)

*24-26. **Conference on Probability Models in Mathematical Physics**, Colorado Springs, CO.

CONFERENCE TOPICS: Rigorous renormalization ideas, including self avoiding random walk and percolation, as well as ideas in functional integration, random fields, and stochastic geometry.

INVITED SPEAKERS: M. Aizenman, K. Alexander, R. Durrett, E. Getzler, L. Gross, T. Hara, J. Imbrie, A. Kupiainen, G. Lawler, C. Newman.

INFORMATION: G.J. Morrow, Dept. of Mathematics, Univ. of Colorado at Colorado Springs, Colorado Springs, CO 80933; email: gjmorrow@colospgs.bitnet.

25-31. **Tenth International Conference on Pattern Recognition**, Resorts Hotel, Atlantic City, NJ. (Mar. 1988, p. 466)

27-June 2. **Lyapunov-Exponents**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

*28-June 1. **Twenty-second Annual Conference on Statistics**, Tours, France.

INFORMATION: J.-P. Asselin de Beauville, Laboratoire d'informatique, Fac. des sciences et techniques, Parc de Grandmont, F-37200 Tours.

*28-June 1. **Tenth International Conference on Distributed Computing Systems**, Paris, France.

INFORMATION: INRIA, Service des Relations Exterieures, B.P. 105, F-78153 Le Chesnay cedex.

*28-June 1. **Mecanique Celeste et Systemes Hamiltoniens**, Marseille, France.

CHAIRMEN: A. Chenciner, Paris; M. Herman, Paris.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

28-June 2. **Geometry of Complex Projective Varieties**, Cetraro, Italy. (Nov. 1989, p. 1250)

29-30. **Algebraic Logic Conference in Honour of Professor Don Monk**, Boulder, Colorado. (Nov. 1989, p. 1250)

*29-31. **GAMM/IFIP Workshop: "Stochastic Optimization: Numerical Methods and Technical Applications"**, Neubiberg, Federal Republic of Germany.

ORGANIZER: K. Marti, UniBw München.

INFORMATION: K. Marti, Univ. der Bundeswehr, München, Werner-Heisenberg-Weg 39, D-8014 Neubiberg.

29-June 1. **Eleventh Annual Conference of the Canadian Applied Mathematics Society**, Halifax, Nova Scotia. (Oct. 1989, p. 1096)

29-June 2. **Dynamical Theories of Turbulence in Fluid Flows**, Minneapolis, MN. (Nov. 1989, p. 1250)

29-June 2. **Workshop on Dynamical Systems in Fluid Mechanics**, Minneapolis, MN. (Nov. 1989, p. 1251)

30-31. **Conference on Algebraic Logic**, Boulder, Colorado. (Dec. 1989, p. 1436)

31-June 3. **Percolation Models of Material Failure**, Cornell University, Ithaca, NY. (Dec. 1989, p. 1436)

June 1990

June/July 1990. **International IMACS Conference on Mathematical Modelling and Applied Mathematics**, Vilnius, USSR. (Sep. 1989, p. 917)

1-8. **Third International Symposium on Orthogonal Polynomials and Their Applications**, Erice-Trapani (Sicily), Italy. (Dec. 1989, p. 1436)

1-10. **Fourth Annual Meeting of the International Workshop in Analysis and its Applications**, Dubrovnik-Kupari, Yugoslavia. (Oct. 1989, p. 1096)

3-6. **1990 Annual Meeting of the Statistical Society of Canada**, St. John's Newfoundland, Canada. (Sep. 1989, p. 917)

*3-6. **Symposium on Chaos in Biological and Agricultural Systems**, Lincoln, Nebraska.

PROGRAM: This will be a symposium to help define statistical approaches to biological systems with chaotic behavior. The purpose is to provide a forum to discuss the implications of nonlinear dynamics to current statistical approaches and to encourage innovative statistical applications.

INVITED SPEAKERS: J.G. Milton, W.M. Schaffer.

CALL FOR PAPERS: The conference will be open to talks or poster sessions made by scientists on statistical issues in the new science of Chaos. Presentation of contributed papers will be restricted to twenty minutes with equal time allotted for discussion. Please submit a one-page single spaced abstract. Submissions should be postmarked no later than March 15, 1990.

INFORMATION: A. Parkhurst, Biology Dept., 103 Miller Hall, University of Nebraska-Lincoln, Lincoln, Nebraska 68583-0712; 402-472-2900.

3-9. **Graphentheorie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

4-7. **Fifth Annual IEEE Symposium on Logic in Computer Science**, Philadelphia, PA. (Sep. 1989, p. 917)

4-8. **Workshop on Model Theory**, Berkeley, CA. (Sep. 1989, p. 917)

4-8. **Nonlinear Phenomena in Atmospheric and Oceanic Sciences**, Minneapolis, MN. (Nov. 1989, p. 1251)

4-8. **International Conference on Approximation Interpolation and Summability**, Honor of A. Jakimovski, Tel Aviv, Israel. (Dec. 1989, p. 1436)

*4-8. **International Conference on Strapping and Related Techniques**, Trier, Federal Republic of Germany.

INFORMATION: W. Sendler, Universität Trier, FB IV, Mathematik, Postfach 3825, D-5500 Trier.

*4-15. **Analyse Harmonique sur Groupes Reductifs P-Adiques**, Marseille, France.

CHAIRMEN: G. Henniart, Paris; P. Kutzko, Iowa; J.-P. Labesse, Paris.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

*6-8. **First IFIP Conference on Fractals**, Lisbon, Portugal.

CHAIRMAN: B. Mandelbrot.
ORGANIZER: L.F. Penedo.
INFORMATION: Portuguese Computer Society (API), Av. Almirante Reis 172,1, 1100 Lisbon, Portugal.

6-9. **Fifth Annual Conference of the European Consortium for Mathematics in Industry**, Lahti, Finland. (Apr. 1989, p. 496)

6-12. **1990 Barcelona Conference on Algebraic Topology**, Centre de Recerca Matematica, Barcelona, Spain. (Sept. 1988, p. 1060)

6-15. **Third Logical Biennial (in honour of S.C. Kleene)**, Chaika (near Varna), Bulgaria. (Oct. 1989, p. 1096)

7-July 4. **1990 Joint Summer Research Conferences in the Mathematical Sciences**, University of Massachusetts at Amherst, MA.

INFORMATION: C. Kohanski, AMS, P.O. Box 6248, Providence, RI 02940.

10-16. **Reelle Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

10-16. **Fourth Czechoslovak Symposium on Combinatorics**, Prachtice, Czechoslovakia. (Nov. 1989, p. 1251)

11-14. **Fourteenth Rolf Nevanlinna Colloquium**, University of Helsinki, Helsinki, Finland. (Jul./Aug. 1989, p. 767)

11-14. **World Organization of Systems and Cybernetics Eighth International Congress**, New York, NY. (Mar. 1989, p. 315)

11-14. **Fifth SIAM Conference on Discrete Mathematics**, Atlanta, GA. (Sep. 1989, p. 917)

11-15. **Chaotic Processes in the Geological Sciences**, Minneapolis, MN. (Nov. 1989, p. 1251)

*11-15. **Third International Conference on Hyperbolic Problems**, Uppsala, Sweden. (Please note changes from Jul./Aug. 1989, p. 767)

PURPOSE: The objective of the conference is to bring together researchers with interest in the theoretical, ap-

plied and computational aspects of hyperbolic partial differential equations.

ORGANIZING COMMITTEE: B. Engquist, B. Gustafsson.

CALL FOR PAPERS: Abstracts for presentations at the conference are invited. The abstract should be at least one full page and at most three pages. The presentation is expected to be twenty minutes. The deadline for the abstracts is February 1, 1990.

11-15. **Rigorous Results in Quantum Dynamics**, Liblice Castle, Czechoslovakia. (May/Jun. 1989, p. 602)

11-15. **NSF/CBMS Conference on Wavelets**, University of Lowell, Lowell, MA. (Nov. 1989, p. 1251)

*11-15. **IMACS First International Conference on Computational Physics**, Boulder, CO.

CALL FOR PAPERS: Contributions in all areas of computational physics are welcomed. Approximately 10 plenary lectures are planned. Special sessions of 5 contributions each, invited by session organizers, will be encouraged. Individual contributed paper sessions will be arranged. Proceedings will be given to all attendees at the conference. Interested contributors are invited to submit a preliminary manuscript or extended abstract as soon as possible.

INFORMATION: For scientific program: K. Gustafson, Chair, IMACS, Computational Physics, c/o D. Ramsey, Scientific Secretary, University of Colorado, Boulder, CO 80309-0425; email: imacs@boulder.colorado.edu. For Registration materials, housing info., and other matters: D. Cook, IMACS Conference Secretary, University of Colorado, Office of Conference Services, Boulder, CO 80309-0454; Fax: 303-492-5959, phone: 303-492-5151.

*12-15. **Ninth International Conference on Analysis and Optimization of Systems**, Antibes, France.

INFORMATION: INRIA, Service des Relations Exterieures, Domaine de Voluceau-Rocquencourt-B.P. 105, F-78153 Le Chesnay cedex.

13-15. **Seventh Annual Quality and Productivity Research Conference**, Madison, WI. (Mar. 1989, p. 315)

13-22. **Free Boundary Problems: Theory and Applications**, Centre de Recherches Mathématiques, Université de Montréal, Canada. (Jul./Aug. 1989, p. 767)

14-16. **Fifth Southeast Asian Conference on Mathematical Education (SEACME 5)**, Gadong, Brunei Darussalam. (Nov. 1989, p. 1251)

*15-20. **Global Differential Geometry and Global Analysis**, Berlin, Federal Republic of Germany.

ORGANIZERS: D. Ferus, U. Pinkall, U. Simon, B. Wegner.

INFORMATION: D. Ferus, Techn. Univ. Berlin, FB 3-Mathematik, Straße des 17. Juni 136, D-1000 Berlin 12.

17-23. **Partial Differential Equations in Complex Analysis**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

18-20. **Joint WNAR-IMS Regional Meeting**, Montana State University, Bozeman, MT. (Mar. 1989, p. 315)

18-22. **Fourteenth Mathematical Sciences Lecture Series on Partially Ordered Sets**, Johns Hopkins University, Baltimore, Maryland. (Oct. 1989, p. 1096)

*18-22. **Approximations Diophantiennes et Nombres Transcendants**, Marseille, France.

CHAIRMAN: P. Philippon, Paris.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

18-29. **Radar/Sonar**, Minneapolis, MN. (Nov. 1989, p. 1251)

*18-29. **AMS-SIAM Summer Seminar on Vortex Dynamics and Vortex Methods**, University of Washington, Seattle, WA.

INFORMATION: B. Verducci, AMS, P.O. Box 6248, Providence, RI 02940.

*20-22. **Sixteenth International Workshop on Graph-Theoretic Concepts in Computer Science**, Berlin, Federal Republic of Germany.

INFORMATION: R.H. Möhring, FB3, MA 6-1, Tech. Univ. Berlin, Straße des 17. Juni 136, D-1000 Berlin 12.

24-30. **Mathematische Probleme in der Nichtlinearen Elastizität**, Oberwolfach,

Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

25-29. **International Symposium on Fuzzy Approach to Reasoning and Decision**

Making, Bochyne, Czechoslovakia. (Oct. 1989, p. 1096)

* 25-29. **Logique et Informatique**, Marseille, France.

CHAIRMAN: G. Blanc, Marseille.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

25-July 13. **SMS-NATO ASI: Shape Optimization and Free Boundaries**, Université de Montréal, Montréal, Canada. (Dec. 1989, p. 1437)

* 27-29. **ACM Conference on Lisp and Functional Programming**, Nice, France.

INFORMATION: Th. Bricheteau, INRIA-Roquencourt, B.P. 105, F-78153 Le Chesnay cedex.

27-30. **Fourth International Congress on Algebraic Hyperstructures and Applications**, Xanthi, Greece. (Apr. 1989, p. 496)

July 1990

July 1990. **AMS Summer Research Institute on Differential Geometry**, University of California, Los Angeles, CA.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

1-7. **Modulfunktionen In Mehreren Variablen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

1-15. **International Symposium on Algebraic Topology - Adams Memorial Symposium**, University of Manchester, England. (Sep. 1989, p. 918)

1-18. **Twentieth Summer Session on Probability Theory**, Saint-Flour (Cantal), France. (Mar. 1989, p. 315)

2-6. **Tenth Australian Statistical Conference/Second Pacific Statistical Congress**, Sydney, Australia. (Jul./Aug. 1989, p. 768)

2-6. **The Jónsson Symposium**, Laugarvatn, Iceland. (Sep. 1989, p. 918)

2-6. **Thirty-fourth Annual Meeting of the Australian Mathematical Society**, Townsville, Queensland, Australia. (Oct. 1989, p. 1097)

* 2-6. **Fifteenth International Biometric Conference**, Budapest, Hungary.

INFORMATION: Fifteenth IBC Secretariat, E. Sós, Computer and Automation Institute, Hungarian Academy of Sciences, P.O. Box 63, H-1502 Budapest.

* 2-7. **Groupes Ordonnés et Groupes de Permutation**, Marseille, France.

CHAIRMAN: M. Giraudet, Mans.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

2-31. **Time Series**, Minneapolis, MN. (Nov. 1989, p. 1252)

3-6. **Eleventh Dundee Conference on Ordinary and Partial Differential Equations**, Dundee, Scotland. (Sep. 1989, p. 918)

6-7. **International Colloquium on Applications of Mathematics (on the occasion of the 80th birthday of Lothar Collatz)**, Hamburg, West Germany. (Nov. 1989, p. 1252)

8-14. **Variationsrechnung**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

9-11. "Universita'di Genova - The Ohio State University Joint Conference" on **New Trends in Systems Theory**, Genoa, Italy. (Jul./Aug. 1989, p. 768)

* 9-14. **4ème Colloque International de Theorie des Graphes et de Combinatoire**, Marseille-Luminy, C.I.R.M., France.

ORGANIZERS: C. Berge, D. Bresson.

INFORMATION: C.A.M.S.-M.S.H. Bureau 226, 54 Bd. Raspail, F-75006 Paris.

9-20. **Geometry and Topology of Four-Manifolds**, McMaster University, Hamilton, Ontario, Canada. (May/Jun. 1989, p. 602)

15-21. **Stochastic Image Models and Algorithms**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

15-22. **1990 European Summer Meeting (Logic Colloquium '90)**, University of Helsinki, Finland. (Nov. 1989, p. 1252)

15-23. **Colloquium in Honor of Roland Fraisse**, Centre International de Rencontres Mathématiques, Luminy, France. (May/Jun. 1989, p. 602)

16-20. **SIAM Annual Meeting**, Chicago, IL. (Nov. 1988, p. 1389)

* 16-20. **Symposium Fraisse**, Marseille, France.

CHAIRMAN: R. Bonnet, Marseille.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

22-28. **Konvexgeometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

* 23-28. **Fourth International Congress Computational and Applied Mathematics**, Leuven, Belgium.

INFORMATION: R. Piessens, K.U.L. Dept. Computer Science, Celestijnenlaan 200 A, B-3030 Heverlee.

26-29. **International Conference on New Trends in Geometric Function Theory and Applications**, University of Madras, Madras, India. (Sep. 1989, p. 918)

29-August 4. **Mechanik Und Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

30-August 4. **The Fourth International Conference on Fibonacci Numbers and their Applications**, Wake Forest University, Winston Salem, NC. (Nov. 1989, p. 1252)

31-August 2. **Dynamics of Numerics and the Numerics of Dynamics**, Bristol, England. (Nov. 1989, p. 1252)

August 1990

* 5-9. **From Topology to Computational Unity and Diversity in the Mathematical Sciences (in Honor of Professor Stephen Smale's 60th Birthday)**, Berkeley, CA.

PURPOSE: To present recent developments in the fields of Professor Smale's research, and to explore the connections between them.

PROGRAM: For each topic there will be one talk summarizing its historical setting and giving an overview of current research, followed by several talks on recent developments. In addition there will be discussion sessions and general talks on Professor Smale's career.

CONFERENCE TOPICS: Differential topology, mathematical economics, dynamical systems, theory of computation, nonlinear functional analysis, physical and biological applications.

ORGANIZING COMMITTEE: G. Debre, N. Kopell, J. Palis, A. Tromba, M.

Hirsch (Chair), J. Marsden, M. Shub, A. Weinstein.

INVITED SPEAKERS: L. Blum, R. Bott, R.G. Chew, G. Debreu, A.T. Fomenko, J. Franks, M. Gromov, M.W. Hirsch, F. Hirzebruch, P. Holmes, J. Kelley, N. Kopell, S. Lang, J. Marsden, A. Mas-Collel, C. McMullen, R.S. Palais, J. Palis, M. Peixoto, P. Rabinowitz, J. Renegar, S. Sastry, M. Shub, D. Sullivan, F. Takens, R. Thom, A. Tromba, K. Uhlenbeck, V.A. Vasiliev, L. Young, E.C. Zeeman.

INFORMATION: D. Craig, Mathematics Department, University of California, Berkeley, CA 94720; email: craig@brahms.berkeley.edu.

5-11. **Mathematical Methods in Tomography**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

5-11. **International Conference on Approximation Theory**, Hungary. (Oct. 1989, p. 1097)

6-7. **AMS Short Course on Combinatorial Games**, Columbus, Ohio.

INFORMATION: M. Foulkes, AMS, P.O. Box 6248, Providence, RI 02940.

6-9. **1990 Joint Statistical Meetings**, Anaheim, CA. (Mar. 1988, p. 466)

8-11. **Joint Mathematics Meetings**, Ohio State University, Columbus, OH. (including the summer meetings of the AMS, AWM, MAA and PME). This is the 75th Anniversary of the MAA.

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

12-18. **Algebraische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

12-18. **Pre-Congress Topology Conference**, University of Hawaii, Honolulu, HI. (Feb. 1989, p. 183)

13-16. **Alaska Conference, Quo Vadis, Graph Theory?**, University of Alaska, Fairbanks, AK. (Oct. 1989, p. 1097)

13-17. **Fifth International Conference on Hadronic Mechanics and Nonpotential Interactions**, University of Northern Iowa, Cedar Falls, Iowa. (Jul./Aug. 1989, p. 768)

13-17. **Eleventh IFAC World Congress**, Tallin, USSR. (Sep. 1989, p. 918)

13-17. **Algebraic Geometry and Analytic Geometry**, Tokyo, Japan. (Sep. 1989, p. 919)

13-17. **1990 International Conference on Parallel Processing**, Pennsylvania State University, University Park, PA. (Dec. 1989, p. 1438)

13-18. **Institute of Mathematical Statistics Fifty-third Annual Meeting** (jointly with the Second World Congress of the Bernoulli Society), Uppsala, Sweden. (Sep. 1989, p. 919)

13-18. **Tsukuba International Conference on Representations of Algebras and Related Topics**, University of Tsukuba, Japan. (Nov. 1989, p. 1253)

14-18. **The Asian Mathematical Conference 1990**, Hong Kong, China. (Sep. 1989, p. 919)

15-19. **International Conference on Knot Theory and Related Topics**, International House, Osaka, Japan. (Apr. 1989, p. 497)

15-20. **Conference on Gaussian Random Fields (The Third Nagoya Lévy Seminar)**, Nagoya University, Nagoya, Japan. (Nov. 1989, p. 1253)

16-18. **SIGAL International Symposium on Algorithms**, Tokyo, Japan. (Oct. 1989, p. 1097)

19-25. **Mathematische Methoden Des VLSI-Entwurfs Und Des Distributed Computings**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

*20-25. **Fifth Conference on Numerical Methods**, Miskolc, Hungary.

ORGANIZERS: P. Rósz, K. Balla, Z. Szarka, A. Lee, I. Faragó, G. Stoyan.
INFORMATION: K. Balla, János Bolyai Math. Society, Pf. 240, H-1368 Budapest.

21-29. **The International Congress of Mathematicians 1990**, Kyoto, Japan. (Nov. 1988, p. 1389)

23-September 1. **Twenty-eighth International Symposium on Functional Equations**, Graz-Mariatrost, Austria. (Dec. 1989, p. 1438)

26-September 1. **Komplexe Analysis**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

*27-31. **Eleventh Prague Conference on Information Theory, Statistical Decision Functions and Random Processes**, Praha, Czechoslovakia.

INFORMATION: 11th Prague Conference, UTIA CSAV, Pod vodárenskou věží 4, 182 08 Praha 8, Czechoslovakia.

28-30. **IMACS European Simulation Meeting on Problem Solving by Simulation**, Esztergom, Hungary. (Mar. 1989, p. 316)

28-31. **Operations Research 1990, International Conference Operations Research**, Vienna, Austria. (Jul./Aug. 1989, p. 768)

30-September 4. **International Conference on Potential Theory**, Nagoya, Japan. (May/Jun. 1989, p. 602)

September 1990

September/October 1990. **IMACS-GAMM Conference on Computer Arithmetic, Scientific Computation and Mathematical Modelling**, Bulgaria. (Sep. 1989, p. 919)

IMACS Symposium on Modelling and Simulation of Electrical Machines, ENSEM - Nancy, France. (May/Jun. 1989, p. 602)

2-7. **Twelfth International Conference on Nonlinear Oscillations**, Cracow, Poland. (Sep. 1989, p. 919)

2-7. **International Conference on Integral Equations and Boundary Value Problems**, Yantai University, Shandong, People's Republic of China. (Nov. 1989, p. 1253)

2-8. **Topologie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

3-6. **Fourth Asian Logic Conference**, Tokyo, Japan. (Mar. 1989, p. 316)

3-7. **IMACS Symposium on Intelligent Models in Systems Simulation**, Brussels, Belgium. (Mar. 1989, p. 316)

3-7. **Representation des Groupes et Analyse Complexe**, Marseille, France. (Jul./Aug. 1989, p. 768)

8-12. **Neuronet-90: IMACS International Symposium on Neural Nets and Neural Computers**, Prague, Czechoslovakia. (Please note change from May/Jun. 1989, p. 602)

9-15. **Surgery and L-Theory**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

*10-12. **Second International Workshop on Advances in Robot Kinematics**, Linz, Australia.

INFORMATION: RISC-LINZ, Research Institute for Symbolic Computation, Johannes Kepler University, A-4040 Linz.

10-14. **Mathematiker-Kongress**, Dresden, German Democratic Republic. (Jul./Aug. 1989, p. 769)

* 10-14. **Greco Calcul Formel**, Marseille, France.

CHAIRMAN: M. Giusti, Palaiseau.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

10-October 5. **School on Qualitative Aspects and Applications of Nonlinear Evolution Equations**, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 602)

16-22. **Risikotheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 17-21. **Atelier International de Theorie des Ensembles**, Marseille, France.

CHAIRMAN: P. Dehornoy, Caen.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

17-22. **DMV-Jahrestagung 1990**, Bremen, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

23-29. **Random Graphs and Combinatorial Structures**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 24-28. **International Symposium on Mathematical Theories**, San Sebastián, Spain. (Please note changes from Jul./Aug. 1989, p. 769)

ORGANIZING COMMITTEE: J. Echeverría, J. Ezquerro, D. Gillies, A. Ibarra, M. Kuokkanen, J. de Lorenzo, M.S. de Mora, T. Mormann, J. Peiffer, J. Pla, A. Vera, Y. Yurramendi.

CONFERENCE TOPICS: Mathematical theories and empirical theories, applications of mathematical theories, history and sociology of mathematical theories, methods of research into mathematics, structures of mathematical theories.

CALL FOR PAPERS: Submission of Abstracts (Max. 400 words): January 30, 1990. Notification of acceptance: March 1, 1990. Submission of papers (Max. 200 words): April 30, 1990. All abstracts should be sent in triplicate to J. Echeverría, SSMT-90, Dept. de Lógica y Filosofía de la Ciencia (UPV/EHU), Apdo. 1249, 20080 San Sebastián (Spain).

* 24-28. **Structure Galoisienne Arithmétique**, Marseille, France.

CHAIRMAN: P. Cassou-Nogues, Bordeaux.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

30-October 6. **Diophantische Approximationen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

October 1990

* 1-5. **Organisations et Theorie des Jeux**, Marseille, France.

CHAIRMAN: L.-A. Gerard-Varet, Marseille, France.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

* 5-6. **Math-History Conference**, LaCrosse, WI.

PURPOSE: This conference is the third of a biennial series. It features two tracks for contributed papers. One will be for original research in Math-History and the other will be for papers of an expository and/or educational nature. The length of presentation should not exceed 30 minutes. Abstracts should be submitted by April 15, and be 200 words or less. Submit abstracts to address below.

ORGANIZERS: I. Anellis, Iowa State Univ.; D.E. Cameron, Univ. of Akron; C.V. Jones, Ball State Univ.; J.D. Wine, Univ. of Wisconsin-LaCrosse (chair).

INVITED SPEAKERS: H. Pycior, Univ. of Wisconsin-Milwaukee; C. Duffy, Massachusetts Maritime Academy; I. Anellis, Iowa State Univ.

INFORMATION: J.D. Wine, Department of Mathematics, University of Wisconsin-LaCrosse, LaCrosse, WI 54601; 608-785-8393.

7-13. **Arbeitsgemeinschaft Mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 8-12. **Congres Franco-Sovietique de Programmation Mathematique**, Marseille, France.

CHAIRMAN: A. Auslender, Clermont-Ferrand.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

14-20. **Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 15-19. **Modeles pour L'Analyse des Données Multidimensionnelles**, Marseille, France.

CHAIRMEN: J.-J. Driesbeke, Bruxelles; P. Tassi, Paris; B. Fichet, Marseille.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

21-27. **Mathematische Methoden In Der Robotik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

21-27. **Arithmetik der Körper**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 1098)

21-27. **International Functional Analysis Meeting on the Occasion of the Sixtyeth Birthday of Professor M. Valdivia**, Peñíscola, Spain. (Oct. 1989, p. 1098)

* 22-25. **Fifth Jerusalem Conference on Information Technology (JCIT-5)**, Jerusalem, Israel.

SPONSORS: Information Processing Society of Israel, Society for Information Management, and the IEEE Computer Society.

PROGRAM: The Fifth JCIT is an international, interdisciplinary conference whose goals are to provide a forum for the presentation of achievements and innovative ideas in all areas of information technology. The conference will cover a broad range of topics in computer technology and applications, and will also explore the economics and management of the information industry. It will provide an interdisciplinary environment for computer scientists, engineers, and managers to exchange views, ideas, and discuss their likely impact on the information systems of the next decade. The official language of the conference is English.

CONFERENCE TOPICS: Computational complexity, cryptography, logic and verification, reasoning about knowledge, artificial intelligence, natural language processing, computer architecture and design, special purpose computers, operating systems

distributed and parallel systems, networks and communications, reliability and performance, software engineering, data bases, knowledge bases, programming languages, computer assisted instruction, computer graphics, computer aided design and manufacturing, robotics, vision, computers in medicine, office automation, innovative applications, and management and economic issues.

CALL FOR PAPERS: Three (3) copies of a full paper should be submitted by February 15, 1990 to one of the Program Chairpersons. Authors will be notified of acceptance or rejection by April 15, 1990. Accepted papers typed on special camera-ready forms for inclusion in the Conference proceedings will be due June 15, 1990.

INFORMATION: J.M. Adams Jr., Director, Membership/Professional Services, Association for Computing Machinery, 11 West 42nd Street, New York, NY 10036; 212-869-7440; email: jimadams@acmvm.bitnet; Fax: 212-869-1228.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

4-10. **Wahrscheinlichkeitsmaße auf Gruppen**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

5-7. **Second SIAM Conference on Linear Algebra in Signals, Systems & Controls**, San Francisco, CA. (Sep. 1989, p. 920)

12-16. **Supercomputing '90**, New York, NY. (Sep. 1989, p. 920)

* 12-16. **Workshop on Representations of Reductive Groups over Finite Fields**, Mathematical Sciences Research Institute, Berkeley, CA.

PROGRAM: This is the first of two workshops planned as part of MSRI's program on Representations of Finite Groups (Fall 1990).

ORGANIZING COMMITTEE: P. Fong (chairman), J.C. Jantzen, B. Parshall, B. Srinivasan.

INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Dr., Berkeley, CA 94720.

18-24. **Komplexitätstheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. **Stochastische Approximation Und Optimierungsprobleme In Der Statistik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. **Lineare Modelle und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

December 1990

2-8. **Multigrid Methods**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

3-5. **First International Symposium on Uncertainty and Analysis: Fuzzy Reasoning, Probabilistic Methods and Risk Management**, College Park, Maryland. (Oct. 1989, p. 1098)

3-7. **1990 Australasian Conference on Combinatorial Mathematics and Computing**, Palmerston North, New Zealand. (Feb. 1989, p. 183)

* 3-7. **SINO-JAPANESE Joint Seminar on Nonlinear PDEs with Emphasis on Reaction-Diffusion Aspects.**, Taipei, Taiwan.

INVITED SPEAKERS: Japan: H. Ikeda, N. Kawano, T. Kusano, H. Matano, M. Mimura, Y. Nishiura, M. Otani, S. Sakaguti, T. Suzuki, I. Takagi, Y. Yamada, S. Yotsutani, E. Yanagida. Taiwan: J.H. Cheng, K.S. Cheng, S.B. Hsu, J. Juang, J.E. Lee, J.H. Lee, C.S. Lin, S.S. Lin, T.P. Liu, W.M. Ni, S.J. Sheu, S.M. Shih, L.Y. Tsai, C.A. Wang, S.H. Wang.

INFORMATION: S.B. Hsu, Institute of Applied Mathematics, National Tsing Hua University, Hsinchu, Taiwan, or, S.S. Lin, Department of Applied Mathematics, National Chiao-Tung University, Hsinchu, Taiwan, or, T. Kusano or M. Mimura, Department of Mathematics, Hiroshima University, Hiroshima, Japan.

* 3-7. **Workshop on General Group Representation Theory**, Mathematical Sciences Research Institute, Berkeley, CA.

PROGRAM: This is the second of two workshops planned as part of MSRI's program on Representations of Finite Groups (Fall 1990).

ORGANIZING COMMITTEE: J.L. Alperin, J.F. Carlson (chairman), W. Feit, G. Robinson.

INFORMATION: I. Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Dr., Berkeley, CA 94720.

9-15. **Allgemeine Ungleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

16-22. **Mathematische Logik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-January 1. **Lineare Modelle Und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

January 1991

* 7-10. **Sixth Caribbean Conference in Combinatorics and Computing**, University of the West Indies, St. Augustine, Trinidad.

INFORMATION: E.J. Farrell, 6 CCCC, Department of Mathematics, The University of the West Indies, St. Augustine, Trinidad.

16-19. **Joint Mathematics Meetings**, San Francisco, CA. (including the an-

nual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

February 1991

- * 25-March 1. **IEEE Computer Society COMPCON Spring '91**, San Francisco, CA.

INFORMATION: COMPCON Spring '91, IEEE Computer Society, 1730 Massachusetts Ave., N.W., Washington, DC 20036-1903; 202-371-1013.

July 1991

- * 1-5. **The Mathematics of Nonlinear Systems**, University of Bath, United Kingdom.

PROGRAM: As part of its Nonlinear Systems initiative, the United Kingdom Science and Engineering Research Council is sponsoring a major international conference to be held at the University of Bath. The aim is to review the importance of recent mathematical contributions to nonlinear science and to look forward to likely future developments.

ORGANIZERS: J.F. Toland, J.M. Ball. INVITED SPEAKERS: J.W. Cahn, C. Fefferman, C. Foias, M. Kruskal, P.D. Lax, A. Libchaber, J.-L. Lions, P.-L.

Lions, A.J. Majda, J.N. Mather, J.W. Milnor, Ya. G. Sinai, L. Tartar, S. Wolfram, V.E. Zakharov.

INFORMATION: J.F. Toland, School of Mathematical Sciences, University of Bath, Claverton Down, Bath BA2 7AY, United Kingdom, phone 0225 826188; email: jft@uk.ac.bath.maths; or, J.M. Ball, Department of Mathematics, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, United Kingdom; phone 031 451 3227; email: mthjmb1@uk.ac.hw.vaxb.

November 1991

- * 18-22. **Supercomputing '91**, Albuquerque, NM.

INFORMATION: R.L. Elliott, Computing and Communications Division, MS B260, Los Alamos National Laboratory, Los Alamos, NM 87545.

February 1992

- * 24-28. **IEEE Computer Society COMPCON Spring '92**, San Francisco, CA.

INFORMATION: COMPCON Spring '92, IEEE Computer Society, 1730 Massachusetts Ave., N.W., Washington, DC 20036-1903; 202-371-1013.

May 1992

- * 29-31. **Twenty-first International Symposium on Multi-Valued Logic**, Sendai, Japan.

INFORMATION: T. Higuchi, Dept. EE, Tohoku Univ., Aoba, Aramaki, Sendai 980, Japan; phone (022) 221800.

June 1992

- 29-July 1. **Joint Meeting with the London Mathematical Society**, Cambridge, England.

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

January 1993

- 13-16. **Joint Mathematics Meetings**, San Antonio, TX. (including the annual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

January 1994

- 5-8. **Joint Mathematics Meetings**, Cincinnati, OH. (including the annual meeting of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

ALGEBRAIC TOPOLOGY

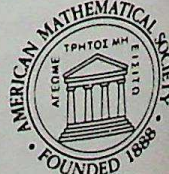
Mark Mahowald and Stewart Priddy
(Contemporary Mathematics, Volume 96)

This book will provide readers with an overview of some of the major developments in current research in algebraic topology. Representing some of the leading researchers in the field, the book contains the proceedings of the International Conference on Algebraic Topology, held at Northwestern University in March, 1988. Several of the lectures at the conference were expository and will therefore appeal to topologists in a broad range of areas.

The primary emphasis of the book is on homotopy theory and its applications. The topics covered include elliptic cohomology, stable and unstable homotopy theory, classifying spaces, and equivariant homotopy and cohomology. Geometric topics—such as knot theory, divisors and configurations on surfaces, foliations, and Siegel spaces—are also discussed. Researchers wishing to follow current trends in algebraic topology will find this book a valuable resource.

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New AMS Publications

NONLINEAR WAVE EQUATIONS

Walter A. Strauss

(CBMS Regional Conference Series, Number 73
Supported by the National Science Foundation)

The theory of nonlinear wave equations in the absence of shocks began in the 1960s. Despite a great deal of recent activity in this area, some major issues remain unsolved, such as sharp conditions for the global existence of solutions with arbitrary initial data, and the global phase portrait in the presence of periodic solutions and traveling waves.

This book, based on lectures presented by the author at George Mason University in January 1989, seeks to present the sharpest results to date in this area. The author surveys the fundamental qualitative properties of the solutions of nonlinear wave equations in the absence of boundaries and shocks. These properties include the existence and regularity of global solutions, strong and weak singularities, asymptotic properties, scattering theory and stability of solitary waves. Wave equations of hyperbolic, Schrödinger, and KdV type are discussed, as well as the Yang-Mills and the Vlasov-Maxwell equations.

The book offers readers a broad overview of the field and an understanding of the most recent developments, as well as the status of some important unsolved problems. Intended for mathematicians and physicists interested in nonlinear waves, this book would be suitable as the basis for an advanced graduate-level course.

Contents

Invariance; Existence; Singularities; Solutions of small amplitude; Scattering; Stability of solitary waves; Yang-Mills equations; Vlasov-Maxwell equations.

1980 *Mathematics Subject Classifications*: 35L70, 35Q20, 35B35, 35P25, 81E10, 82A45

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WEAK CONVERGENCE METHODS FOR NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS

Lawrence C. Evans

(CBMS Regional Conference Series, Number 74
Supported by the National Science Foundation)

The purpose of this book is to explain systematically and early many of the most important techniques set forth in

recent years for using weak convergence methods to study nonlinear partial differential equations. This work represents an expanded version of a series of ten talks presented by the author at Loyola University of Chicago in the summer of 1988.

The author surveys a wide collection of techniques for showing the existence of solutions to various nonlinear partial differential equations, especially when strong analytic estimates are unavailable. The overall guiding viewpoint is that when a sequence of approximate solutions converges only weakly, one must exploit the nonlinear structure of the PDE to justify passing to limits. The author concentrates on several areas that are rapidly developing and points to some underlying viewpoints common to them all. Among the several themes in the book are the primary role of measure theory and real analysis (as opposed to functional analysis) and the continual use in diverse settings of low amplitude, high frequency periodic test functions to extract useful information. The author uses the simplest problems possible to illustrate various key techniques.

Aimed at research mathematicians in the field of nonlinear PDEs, this book should prove an important resource for understanding the techniques being used at the forefront of this vital area of research.

Contents

Weak convergence: Review of basic theory; Convergence of averages; Compactness in Sobolev spaces; Measures of Concentration; Measures of Oscillation; **Convexity**: The calculus of variations; Weak lower semicontinuity; Convergence of energies and strong convergence; **Quasiconvexity**: Definitions; Weak lower semicontinuity; Convergence of energies and strong convergence; Partial regularity of minimizers; Examples; **Concentrated compactness**: Variational problems; Concentration-Cancellation; **Compensated compactness**: Direct methods; Div-curl lemma; Elliptic systems; Conservation laws; Generalization of Div-curl lemma; **Maximum principle methods**: The maximum principle for fully nonlinear PDE; Homogenization of nondivergence structure PDE; Singular perturbations.

1980 *Mathematics Subject Classifications*: 35A05, 35A15, 35B50, 35J60, 35L65, 46E85

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COLORING THEORIES

Steve Fisk

(Contemporary Mathematics, Volume 103)

The focus of this work is the study of global properties of various kinds of colorings and maps of simplicial complexes. In addition to the usual sorts of coloring, the author studies colorings determined by groups, colorings based on regular polyhedra, and continuous colorings in finitely and infinitely many colors. The emphasis is on how all the colorings fit together, rather than on the existence of colorings or the number of colorings. Beginning with some fundamental properties of simplicial complexes and colorings, the author shows how colorings relate to various aspects of group theory, geometry, graph theory, and topology.

Contents

Properties of the combinatorial category; The symmetric group complex S_n ; Complexes arising from geometry; Graphs; Complexes with a structure group; Reflexive and self dual complexes; Continuous colorings; Coloring with arbitrary complexes.

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with 2-categorical methods, and a useful tool for studying toposes and other categories.

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Preliminaries: κ -filtered colimits; κ -flat functors; **Accessible categories and functors**: κ -accessible categories; Small categories and accessibility; Raising the index of accessibility; Accessible functors; An equivalent definition of accessibility; **Sketches and logic**: Sketches; Logic; The downward Löwenheim-Skolem theorem; Examples; **Sketching accessible categories**: Preliminaries on 2-categories; The canonical sketch associated with a κ -accessible category; Small sketches for an accessible category; Diagrams of accessible categories and diagrams of sketches; Axiomatizing an accessible subcategory; **Limits and colimits of accessible categories**: Colimits of sketches and limits of accessible categories; Some results concerning Grothendieck toposes; Accessible fibrations; Lax colimits of accessible categories; The powerful image of an accessible functor; **Limits and colimits in accessible categories**: Completeness and cocompleteness in accessible categories; Models of a sketch in an accessible category; Detectability of colimits; Completing an accessible category.

1980 *Mathematics Subject Classifications*: 18C10, 03G30, 03C95, 18D05; 18B25, 03E55, 03C75

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MathSci USER GUIDE, Second Edition

This is the second edition of the *MathSci User Guide*, which provides support and documentation for users of MathSci, the online database covering the world's literature in all areas of mathematics, computer science, and statistics. This handy reference will prove invaluable to the many users who now access MathSci online, from tapes, or on compact disc.

The *MathSci User Guide* provides complete instructions on the use of MathSci. Instructions on getting started, descriptions of aspects of the database, sample searches, information on source publications, explanation of the classification schemes, lists of subject words and keywords, and institution codes and addresses are all in this comprehensive manual. In addition, there is a description of how to use the computer typesetting system \TeX to typeset MathSci records directly from the database, and appendices on transliteration of the Cyrillic alphabet and Chinese names, on mnemonics representing mathematical symbols, and on \TeX codes used in MathSci.

The MathSci database is derived from six printed publications, *Mathematical Reviews*, *Current Mathematical Publications*, *Current Index to Statistics*, *Index to Statistics and Probability*, *Computing Reviews*, and the *ACM Guide to Computing Literature*. Making this broad range of information available, the *MathSci User Guide* will prove useful to researchers as well as librarians.

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ACCESSIBLE CATEGORIES: THE FOUNDATIONS OF CATEGORICAL MODEL THEORY

Michael Makkai and Robert Paré

(Contemporary Mathematics, Volume 104)

Intended for category theorists and logicians familiar with basic category theory, this book focuses on categorical model theory, which is concerned with the categories of models of infinitary first order theories, called accessible categories. The starting point is a characterization of accessible categories in terms of concepts familiar from Gabriel-Ulmer's theory of locally presentable categories. Most of the work centers on various constructions (such as weighted bilimits and lax colimits), which, when performed on accessible categories, yield new accessible categories. These constructions are necessarily 2-categorical in nature; the authors cover some aspects of 2-category theory, in addition to some basic model theory, and some set theory. One of the main tools used in this study is the theory of mixed sketches, which the authors specialize to give concrete results about model theory. Many examples illustrate the extent of applicability of these concepts. In particular, some applications to topos theory are given.

Perhaps the book's most significant contribution is the way it sets model theory in categorical terms, opening the door for further work along these lines. Requiring a basic background in category theory, this book will provide readers with an understanding of model theory in categorical terms, familiarity

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NEW SERIES

University Lecture Series

The AMS is pleased to announce the University Lecture Series. This new book series provides a way for excellent, and sometimes inspired, lecture series to reach an audience beyond those able to attend the live lectures. Presented by the outstanding mathematicians of our day, these lectures will be important for their mathematical insight and depth, as well as for their historical and archival value. The inaugural volume in the University Lecture Series is described below.

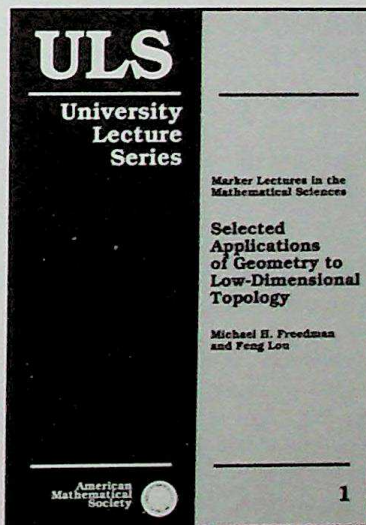
Selected Applications of Geometry to Low-Dimensional Topology

Michael H. Freedman and Feng Luo

(University Lecture Series, Volume 1)

This book, the inaugural volume in the new University Lecture Series, is based on lectures presented at Pennsylvania State University in February 1987. The Lectures attempt to give a taste of the accomplishments of manifold topology over the last 30 years. By the late 1950s, algebra and topology had produced a successful and beautiful fusion. Geometric methods and insight, now vitally important in topology, encompass analytic objects such as instantons and minimal surfaces, as well as nondifferentiable constructions.

Keeping technical details to a minimum, the authors lead the reader on a fascinating exploration of several developments in geometric topology. They begin with the notions of manifold and smooth structures and the Gauss-Bonnet theorem, and



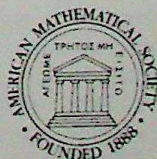
proceed to the topology and geometry of foliated 3-manifolds. They also explain, in terms of general position, why four-dimensional space has special attributes, and they examine the insight Donaldson theory brings. The book ends with a chapter on exotic structures on R^4 , with a discussion of the two competing theories of four-dimensional manifolds, one topological and one smooth.

Background material was added to clarify the discussions in the lectures, and references for more detailed study are included. Suitable for graduate students and researchers in mathematics and the physical sciences, the book requires only background in undergraduate mathematics. It should prove valuable for those wishing a not-too-technical introduction to this vital area of current research.

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POSITIONS AVAILABLE

UNIVERSITY OF CALIFORNIA SANTA CRUZ

The Mathematics Department at the University of California, Santa Cruz is recruiting for a position in algebra or number theory, at either the Assistant (tenure-track) or Associate Professor (tenured) level. Salary will be in the range of \$33,900-\$36,600 (Asst. Prof.) or \$40,400-\$45,200 (Assoc. Prof.), effective July 1, 1990. The teaching load is 4 one-quarter courses per year. Minimal qualification is a Ph.D. or equivalent in math. Candidates at the tenure level are expected to have an exceptionally strong research record as well as a solid teaching record. Candidates at the untenured level should demonstrate the potential for such. Applicants should send vita, including teaching and research record (indicating at which level you wish to be considered), and four letters of recommendation to: Recruitment Committee, Mathematics Department, University of California, Santa Cruz, CA 95064. Closing Date: February 1, 1990. Please refer to #190-890 in your reply. Applications from women and minorities are particularly welcomed. UCSC IS AN EEO/AA/IRCA EMPLOYER.

UNIVERSITY OF SOUTHERN CALIFORNIA LOS ANGELES, CALIFORNIA 90089-1113

The Division of Natural Sciences and Mathematics at USC has begun a five-year, \$50 million Science Initiative. Several tenure-track Assistant Professorships and possible tenured positions at Associate Professor and Professor are anticipated for 1990-91 in Mathematics. Visiting positions (at all levels) and postdoctoral appointments will also be available.

Any research area in pure or applied mathematics or statistics will be considered, including but not restricted to: Algebraic Geometry, Biomathematics, Control Theory, Differential Geometry, Dynamical Systems, Functional Analysis, Group Theory, Number Theory, Numerical Analysis, Ordinary or Partial Differential Equations, Probability, Ring Theory, Statistics, and Topology.

Assistant Professors teach two courses per semester, must show strong research promise, and preferably should work in one of the above areas. Applicants for senior positions must have an outstanding record of research and scholastic achievement. Address inquiries to: Chair of Appointments Committee/Department of Mathematics-DRB 306/Los Angeles, CA 90089-1113. EOE/AA.

TRENTON STATE COLLEGE DEPARTMENT OF MATHEMATICS AND STATISTICS

ANTICIPATED FACULTY VACANCIES FOR FALL, 1990.

Assistant Professor of Mathematics Tenure track. Req'd: Ph.D. (or within one year of completion); demonstrated commitment to quality teaching; strong research potential. Both pure and applied mathematics will be considered.

Assistant Professor of Statistics Tenure track. Req'd: Ph.D. in Statistics (or within one year of completion); demonstrated commitment to quality teaching; strong research potential. Both theoretical and applied statisticians will be considered.

Assistant Professor of Mathematics Education Tenure track. Req'd: Ph.D. or Ed.D. in Mathematics Education (or within one year of completion); demonstrated commitment to quality teaching, ability to teach both undergraduate and graduate mathematics courses, as well as supervise field experience; strong research potential.

Send vita and three letters of recommendation to: Dr. Aigli Papantonopoulou, Chair, Search Committee, Department of Mathematics and Statistics, Trenton State College, Hillwood Lakes CN4700, Trenton, NJ 08650-4700.

Application deadline is March 1, 1990, or until positions are filled. Non U.S. citizens must include statement of current visa status.

The department enrolls every year an average of forty liberal arts majors in mathematics who have the option to concentrate in statistics or in mathematics education. A graduate program offers a Master's degree in mathematics.

Trenton State College has earned national recognition as a highly competitive undergraduate institution. TSC is located on 224 acres in Ewing Township, within seven miles of Central New Jersey's research corridor.

To enrich education through diversity, TSC is an AA/EOE.

COLBY-SAWYER COLLEGE

Mathematics Faculty. Teach a variety of mathematics courses from developmental courses to applied calculus. Assist in curriculum development, student placement and advising. Near completion of an advanced degree desired. Colby-Sawyer is a small independent college located in beautiful New Hampshire. We value teaching skills and commitment to the student. Letter of application, resume and names of five references to: Director of Human Resources, Colby-Sawyer College, New London, NH 03257. EOE.

POSITIONS AVAILABLE

THE AUSTRALIAN NATIONAL UNIVERSITY SCHOOL OF MATHEMATICAL SCIENCES

The School of Mathematical Sciences is a campus-wide school encompassing the Department of Mathematics in the Faculty of Science, the Centre for Mathematical Analysis, which is one of the Australian Government's Special research Centres, and the Mathematics and the Statistics Research Sections in the Institute of Advanced Studies. The School is embarking on a major expansion of its activities in advanced computation, including computational mathematics, computer intensive statistics and numerical analysis. As part of these developments, the School seeks suitably qualified applicants for the following positions. Lecturer/Senior Lecturer (tenurable) in Computation Mathematics, Department of Mathematics. The successful candidate will be expected, particularly if appointed as a senior lecturer, to take a leading role in the development of the Department's undergraduate courses in computational mathematics and numerical analysis. Applicants should possess a PhD in a relevant discipline with a strong background in computational mathematics and/or numerical analysis. Depending on the interests and qualifications of applicants it may be possible to make two appointments jointly with the Centre for Mathematical Analysis or one of the Research Sections. In such circumstances, the second appointment would be for a fixed term. For further information contact: Dr. R. A. Bryce, Department of Mathematics, Tel: (02) 492921; Fax (02) 495549; Email: bryrmath@fac.anu.oz. Closing date: 28 February 1990. Ref: SMS 22.11.1. Research Positions in Advanced Computation. Applications are invited for suitably qualified persons for appointment as Postdoctoral, Research or Senior Research Fellow within the special areas of (i) computational mathematics, including applications to non-linear modelling or symbolic and exact computation, or (ii) computer intensive statistical methods. No teaching is required, but some participation in advanced undergraduate courses may be available. Applications from those able to take leave of absence from their own institution will be welcomed. Persons interested in fractional appointments are encouraged to apply. Expressions of interest are also invited for a possible joint appointment with the Division of Mathematics and Statistics, CSIRO, which would involve collaborating with Australian Industry to identify and solve important problems in computer intensive statistics. An appointee to such a position would divide their time between the ANU and CSIRO, Melbourne. For further information contact: Professor C. C. Heyde, School of Mathe-

mathematical Sciences, Tel: (02) 492957; Fax: (02) 490759. Closing date: 28 February 1990 Ref: SMS 22.11.2. Research Associate/Research Fellow (ARC). A Research Associate or Research Fellow is required to work with Professor M. N. Barber on a project concerned with mathematical and computational aspects of the dynamics of solidification and the evolution of solidification fronts. The project is funded by the Australian Research Council for up to three years from January 1, 1990. The level of appointment will be determined by qualifications and experience. A PhD in applied or computational mathematics or theoretical physics is a necessary qualification, while a strong mathematical background in differential equations and/or experience in numerically intensive computation would be desirable. It is anticipated that the project will involve use of the VP100 supercomputer at the ANU. For further information contact: Professor M. N. Barber, Department of Mathematics, Tel: (02) 494179; Fax: (02) 495549; Email: barmmath@fac.anu.oz. Closing date: 28 February 1990. Ref: SMS 22.11.3. SALARY: Senior Lecturer; A\$42703-A\$49529; Lecturer; A\$32197-A\$41841; Senior Research Fellow; A\$44397-A\$52675; Research Fellow; A\$32197-A\$41841; Postdoctoral Fellow Grade 1 (fixed point)-Research Associate); A\$27953-A\$31808. APPOINTMENT: Senior Research Fellow/Research Fellow up to three years, possibility of extension to five years; Postdoctoral Fellow normally two years, possibility of extension to three years. APPLICATIONS should be submitted in duplicate to the Registrar, The Australian National University, G P O Box 4, Canberra ACT 2601 AUSTRALIA, quoting reference number and including curriculum vitae, list of publications and names of at least three referees. The University reserves the right not to make an appointment or to appoint by invitation at any time. Further information is available from the Registrar.

THE UNIVERSITY IS AN EQUAL OPPORTUNITY EMPLOYER.

AUSTIN COLLEGE FACULTY POSITION IN MATHEMATICS

ASSISTANT PROFESSOR, tenure-track, beginning Fall 1990. Ph.D. in mathematics (or ABD), a commitment to teaching excellence in a liberal arts environment, and continued scholarly development required. Preferred fields are algebra and analysis. Occasional assignments to college-wide curricular programs. Send letter of application, transcripts and three letters of reference by February 15, 1990, to David W. Jordan, Dean of Faculty, Austin College, Sherman, TX 75091-1177. Salary and benefit program competitive. EOE.

KENT STATE UNIVERSITY Department of Mathematical Sciences Senior Position in Applied Mathematics/Scientific Computation

Applications are invited for a faculty position at the associate or full professor level beginning Fall Semester 1990. The ideal candidate would have a strong training in classical applied mathematics and some experience with large-scale scientific computation. He or she would be expected to have a solid record of research, publication, and external funding, as well as a commitment to quality teaching. The appointed faculty member would be expected to enhance the Department's outreach and interdisciplinary research efforts, supervise graduate students, and contribute to curricular planning and development. A competitive salary is available.

The Department of Mathematical Science at Kent State University comprises pure and applied mathematics, statistics, computer science, and the Institute for Computational Mathematics. This new position is intended to complement existing strengths in applied analysis (especially numerical analysis and approximation theory) and computer science (especially symbolic computation, expert systems, and parallel computing).

The infrastructure of the Department is very good: the equipment inventory includes 2 VAX mini-computers plus Encore, Sequent, Staran, and Warp parallel-processing computers and a variety of work-stations and peripherals. The University also maintains an IBM 3090 mainframe and a high-performance (interactive) link to the Cray Y-MP/864 at the Ohio Supercomputer Center in Columbus, on which computing time is readily available.

Kent State University is attractively set in the rolling hills of northeast Ohio 40 minutes southeast of Cleveland and 20 minutes east of Akron. Some of the main research centers in the area include the University's internationally known Glenn H. Brown Liquid Crystal Institute, NASA Lewis Research Center in Cleveland, and Loral Systems (formerly Goodyear Aerospace) in Akron.

Application deadline is February 24, 1990.

If qualified individuals do not apply by February 24, 1990, the deadline will be extended until the position is filled or until August 18, 1990, whichever occurs first. Applicants should submit a resume and arrange to have three letters of recommendation sent to Chuck Gartland, Chair of the Applied Mathematics Search Committee, Department of Mathematical Sciences, Kent State University, Kent, OH 44242. Kent State University is an Affirmative Action/Equal Opportunity Employer.

POSITIONS AVAILABLE

UNIVERSITY OF CALIFORNIA LOS ANGELES Department of Mathematics

TEMPORARY POSITIONS

(1) Two E. R. Hedrick Assistant Professorships. Applicants must show very strong promise in research and teaching. Salary \$37,000. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate's field. Preference will be given to applications completed by January 1, 1990.

(2) Two or three Research Assistant Professorships in Computational and Applied Mathematics. Applicants must show very strong promise in research and teaching. Salary \$37,000. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate's field. Preference will be given to applications completed by January 1, 1990.

(3) One or two Assistant Professorships in the Program in Computing (PIC). Applicants must show very strong promise in teaching and research, preferably in the general area of Logic, Language and Computation. Teaching load: four quarter programming courses and an advanced quarter course of the candidate's choice per year. Two year appointment, possibly renewable once or twice. Salary range: \$37,000-\$44,000. Preference will be given to applications completed by January 1, 1990.

(4) One or two Lectureships in the Program in Computing (PIC). Applicants must show very strong promise in the teaching of programming. Teaching load: five quarter programming courses per year. One year appointment, possibly renewable up to four times. Salary depends on experience, begins at \$31,200.

(5) Subject to administrative approval, a few adjunct assistant professorships. Two year appointments. Strong research and teaching background required. Salary \$32,400-\$36,500 per year. Teaching load: five quarter courses per year.

(6) Several positions for visitors and lecturers.

To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search.

UCLA is an equal opportunity/affirmative action employer.

UNIVERSITY OF CALIFORNIA RIVERSIDE Announcement Chairperson and Professor Department of Mathematics

The College of Natural and Agricultural Sciences invites applications and nominations for the position of Chairperson and Professor of the Department of Mathematics, effective July 1, 1990. The department is responsible for both undergraduate and graduate teaching in one of the fastest growing universities in the country. Currently the department has twenty-eight full-time faculty with emphases in algebra, geometry, topology, and analysis combinatorics. There are 106 undergraduate majors and 36 graduate students.

Preference will be given to candidates capable of providing leadership in both the department and profession and in representing the faculty's perspective in the college; enhancing faculty performance and extramural support and connecting the various program interests in computing with a new College of Engineering. Candidates for the position should have the following qualifications: an earned doctorate in mathematics; a distinguished record of scholarship, teaching and service appropriate for the appointment as full professor; demonstrated administrative skills; and a strong commitment to academic values and the principles of affirmative action.

The chairperson reports to the Dean of the College of Natural and Agricultural Sciences and is responsible for providing leadership and representing faculty in matters such as teaching, personnel, and budget. Chairpersons are appointed for up to five years and may be reviewed. Salary will be commensurate with qualifications and experience. The faculty appointment is a nine-month position with additional compensation for duties while chairperson. The closing date for applications will be February 15, 1990. A letter of intent, along with a curriculum vitae, and the names, addresses and phone numbers of at least three references should be sent to:

Dr. Seymour D. Van Gundy
Interim Dean, College of Natural and
Agricultural Sciences
University of California Riverside
Riverside, CA 92521

The University of California, Riverside is an Equal Opportunity, Affirmative Action Employer. Women and Minorities are encouraged to apply.

ROLLINS COLLEGE Department of Mathematical Sciences Winter Park, FL 32789

One tenure track position, preferably at the Assistant Professor level, is available for September, 1990, pending approval. The area of specialization is open but a Doctorate (or ABD with degree nearing completion) strong commitment to teaching undergraduates and continued professional development is required. We seek a versatile, broadly educated mathematician who can work collegially in a ten-person Department in a liberal arts setting. The Department offers majors in mathematics and computer science, is currently engaged in a calculus renewal project (funded by NSF) and is well-equipped with Macintosh II computers. The teaching load is 8-10 hours per week. Winter Park, a delightful city of 40,000, is located in the greater Orlando area. To ensure full consideration, applications must be complete by 15 Feb. 1990. Send resume, transcripts and three letters of recommendation (at least one of which must comment on teaching) to: David Kurtz, Chair. Rollins College is an affirmative action/equal opportunity employer and women and members of minority groups are encouraged to apply.

THE UNIVERSITY OF SCRANTON Mathematics Department

The University of Scranton is a Jesuit university with over 3,500 undergraduates. The Mathematics Department is newly formed from a split in a combined Mathematics/Computer Science Department. It has 15 full time faculty and about 50 majors.

Four tenure-track positions are available for Fall 1990 for faculty interested in a teaching environment where research is encouraged and supported. Individuals with expertise in any area of mathematics will be considered. Preferred areas include Applied Mathematics, Probability/Statistics, Actuarial Mathematics, Algebra, and Analysis. Rank and salary are open and competitive.

Submit a vita, transcripts, and three references to Mathematics Faculty Search Committee, University of Scranton, Scranton, PA 18510 or phone (717) 961-7774. Screening will begin at once and applications will be considered until all positions have been filled. An AA/EO Employer and Educator.

POSITIONS AVAILABLE

DENISON UNIVERSITY

Three positions, preferably at the Assistant Professor level, in the Department of Mathematical Sciences. The first position is non-tenurable and starts in January 1990. A Master's degree in mathematics or computer science is required; preference will be given to those having a background in computer science or holding the Ph.D. Applicants for this position can (if they choose) simultaneously be candidates for one of the tenurable positions.

The second position is in computer science and is tenurable with a starting date of Fall, 1990. It requires a Ph.D. (in hand or to be attained shortly following employment) in computer science or in a related field. The third position, also tenurable, is in mathematics (any specialty) and requires a Ph.D. (in hand or to be attained shortly following employment) in mathematics. It also starts in the Fall of 1990. Teaching loads are 5 and 6 courses per year for computer science and mathematics respectively.

The primary responsibility of both positions is teaching; a commitment to quality instruction is essential. Some research is expected of those in tenurable positions. Denison University is a liberal arts college of 2,100 students located in a village of 4,000, seven miles from Newark (population 50,000) and twenty-five miles east of Columbus. The Department of Mathematical Sciences offers B.A. and B.S. degrees in mathematics and computer science as well as a mathematics-economics joint B.A. degree. The department consists of 10 full-time faculty members. Four members of the department have advanced degrees in computer science.

Every faculty office is equipped with a DOS/UNIX workstation connected to larger computers over a departmental network. The Department operates a classroom/laboratory facility with 21 IBM-PC equivalents connected to a 3B2/400 via a StarLAN network and it uses a symbolic computation facility consisting of two 3B2/1000 systems and a SUN Microsystems 4/280 Computer. The University computing facilities consist of a VAX 11/6210, and VAX 11/785.

Send resume and transcripts of graduate work to Professor Zaven A. Karian, Chairman, Department of Mathematical Sciences, Denison University, Granville, OH 43023. Also ask three persons who know you well to send reference letters in support of your application (at least one letter should address your teaching). For the non-tenurable position, applications will be reviewed as they are received. Applications for the tenurable positions should be made by February 5, 1990; applications beyond this date will be consid-

ered until the positions are filled. Denison is an Affirmative Action/Equal Opportunity Employer; women and minorities are encouraged to apply.

WESTERN WASHINGTON UNIVERSITY

Applications are invited for tenure-track and visiting positions to begin Fall 1990. Successful candidates will be expected to be active in research, to interact at the research level with current department members, and to be good teachers with a commitment to both undergraduate and graduate education.

Candidates in the following areas of mathematics are especially sought, although outstanding candidates in other areas consistent with departmental goals may also be considered: dynamical systems, optimization, graph theory. A Ph.D. in Mathematics is required.

Candidates are also sought in mathematics education, especially secondary education. Responsibilities will include teaching upper division mathematics courses and mathematics methods courses, and participation in the development of an active in-service program. A Ph.D. in Mathematics or Mathematics Education is required. Elementary/secondary teaching experience is desirable.

Rank and salary are open, but a substantial research record will be required for appointments above the Assistant Professor level. The normal teaching load for research faculty is two courses per quarter.

Western Washington University is located on Bellingham Bay in an area of outstanding natural beauty within an hour's drive of the Seattle and Vancouver, B.C. metropolitan areas and the Cascade Mountains. The department has a strong undergraduate program with a somewhat applied flavor and a flourishing Master's program with more than twenty students.

Applications should be sent to Professor Thomas T. Read, Chairman, Department of Mathematics, Western Washington University, Bellingham, WA 98225.

Interested candidates should submit a letter of application, complete transcripts, a vita, and three letters of recommendation. Deadline for applications is February 1, 1990; later applications will be considered if positions remain available. Positions are subject to the continuing availability of funds. The University is an EO/AA employer.

WEST VIRGINIA UNIVERSITY EBERLY PROFESSORSHIP IN MATHEMATICS

The Department of Mathematics invites applications and nominations for the EBERLY PROFESSORSHIP IN MATHEMATICS. Candidates are sought who have outstanding scholarly accomplishments, research interests which complement current areas of concentration in applied analysis or discrete mathematics, a record of funded research, and a commitment to instruction. The individual selected will be expected to provide academic leadership with continued excellence in these areas. The position will commence August 1990. Applications, nominations and inquiries should be directed to James Lightbourne, Department of Mathematics, West Virginia University, Morgantown WV 26506. Candidates should submit a letter of application, vita, and names and addresses of five references. Applications will be reviewed as received and accepted until the position is filled. WVU is an affirmative action/equal opportunity employer. Qualified women and minorities are especially encouraged to apply.

COLLEGE OF CHARLESTON DEPARTMENT OF MATHEMATICS

Applications are invited for at least 2 tenure-track positions at the Assistant Professor level beginning August 1990. Candidates must have a Ph.D. in one of the mathematical sciences, a commitment to undergraduate teaching, and potential for continuing research. The normal teaching load is 9 hrs/wk for those engaged in research. The salary is competitive. Applicants should send a vita and have three letters of recommendation sent to William L. Golightly, Chairman, Department of Mathematics, College of Charleston, Charleston, SC 29424. The process of evaluating applications will begin on January 22, 1990, but applications will be considered until the positions are filled. The College of Charleston is an Affirmative Action/Equal Opportunity Employer.

POSITIONS AVAILABLE

INDIANA STATE UNIVERSITY CHAIRPERSON DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

The Department of Mathematics and Computer Science, Indiana State University, invites applications for the position of Chairperson. Applicants should have a doctorate in Mathematics or Computer Science, a record of successful teaching and research, and a commitment to promoting research, teaching, and other scholarly activities. In addition applicants should have a potential for administering a department with both Mathematics and Computer Science degree programs. The Computer Science area is undergoing active development, so familiarity with Computer Science curricular issues is desirable.

The Department offers BS and BA degrees in Mathematics and Computer Science. It also offers MS and MA degrees in Mathematics and it is developing an MS degree in Computer Science. There are 25 faculty positions. The Department has an 8 processor Sequent and a VAX minicomputer and a microcomputer laboratory.

Salary and rank are commensurate with qualifications and experience. Please send a letter of application, vita and three letters of recommendation to:

Dr. David Hutchison, Chairperson
Search Committee
Department of Mathematics and
Computer Science
Indiana State University
Terre Haute, IN 47809

Applications received after February 1, 1990 cannot be guaranteed consideration. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Reform and Control Act of 1986). Indiana State University is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF TEXAS AT ARLINGTON

We expect to fill several positions beginning the Fall semester of 1990 (five tenure-track positions were filled in 1988 and 1989). Salary and rank are commensurate with qualifications. The selected candidates must have excellent credentials in research and teaching. The desired areas of expertise are Differential or Algebraic Geometry, Computational Geometry, Partial differential Equations, Functional Analysis, Statistics and Applied Mathematics. A resume with three letters of recommendation should be sent to: C. Corduneanu, Department of Mathematics, UTA Box 19408, Arlington, Texas 76019. UTA is an Affirmative Action/Equal Opportunity Employer.

COLUMBIA UNIVERSITY Department of Computer Science Lectureships

Positions as Lecturer or Senior Lecturer will be offered to excellent teachers with superior research and academic backgrounds. Faculty of all ranks in other mathematical disciplines, as well as computer science, are encouraged to apply for these non-tenured term appointments, whose duration will typically be three to six years. Pay is comparable to professorial levels.

These lectureships provide an opportunity for teacher/scholars with some substantial prior computing experience to make a transition to computer science. Columbia University has an outstanding young research faculty and facilities, now working in a five-million dollar office and research-laboratory building. All of our "lecturer alumni" are presently in good positions at leading universities and colleges.

Lecturers will teach two undergraduate courses each semester. They must be able to make highly effective presentations to large classes. The University has several SUN 4 computer systems dedicated to instructional use. Many terminals for students are in dormitories and other convenient locations. Knowledge of innovative uses of technology for teaching is desirable.

Send resume and three letters of reference by February 15, 1990, if possible, to Lecturer Recruiting, Department of Computer Science, Columbia University, New York, New York 10027.

Columbia University is an Equal Opportunity/Affirmative Action Employer. We are interested in receiving applications from qualified women and minorities.

UNIVERSITY OF SOUTHERN COLORADO DEPARTMENT OF MATHEMATICS PUEBLO, CO 81001-4901

Applications are invited for several tenure-track assistant professor positions for Fall 1990. Doctorate in Mathematics required. Evidence of commitment to teaching excellence necessary. Active research desirable. Send letter of application, resume, graduate transcripts, and three letters of reference to Search and Screen Committee. Evaluation of applications will begin 7 February 1990 and continue until positions are filled. USC is an AA/EO employer.

UNIVERSITY OF SOUTHERN CALIFORNIA Department of Mathematics Chairperson

The University of Southern California invites applications and recommendations for the faculty position of Chairperson of the Department of Mathematics (at the rank of Professor). The Department has a faculty of about 45 members, representing many areas in pure and applied mathematics. The Division of Natural Sciences and Mathematics has begun a \$50 million Science Initiative which is expected to increment the Division's annual budget by about \$15 million after five years. The opportunities for growth and enhancement of the Department are substantial.

The Department offers PhD and master's degrees in both pure and applied mathematics, and a master's degree in statistics (with a PhD program planned). A new Center for Applied Mathematical Sciences, under the direction of H. T. Banks, has been established and offers an extensive program of visiting and seminars. The Department also has large computer-assisted learning center for undergraduates and a statistics laboratory.

Candidates for the position must have an outstanding record of research and scholarship and must be ready to assume academic leadership and administrative direction of a broadly-based university department which is in the process of expanding. If interested, send a vita and names of references to:

Chair Search Committee
Department of Mathematics
University of Southern California
Los Angeles, CA 90089-1113

USC is an Equal Opportunity/Affirmative Action employer.

CLEVELAND STATE UNIVERSITY Department of Mathematics

Applications are invited for anticipated openings for tenure-track Assistant Professor starting September 1990 and Visiting Assistant/Associate Professor for Spring Semester 1990. Candidates should have a strong research record and a commitment to excellent teaching. Research areas compatible with those in the Department are preferred, especially for the visiting position. Send reprints/preprints and three letters of recommendation to: John Chao, Department of Mathematics, Cleveland State University, 24th & Euclid Ave., Cleveland, OH 44115. USC is an Equal Opportunity Employer, m/f/h.

POSITIONS AVAILABLE

CALIFORNIA STATE UNIVERSITY, CHICO Department of Mathematics and Statistics Assistant Professor of Mathematics/ Lecturer in Mathematics

The Department is offering a tenure-track position at the Assistant Professor level, and one or more one-year fulltime temporary positions, for the 1990-91 academic year. A Ph.D. in Mathematics or Statistics and evidence of teaching excellence are required. Candidates in mathematical statistics are particularly encouraged to apply, but candidates in all areas will be considered. Faculty teach 12 hours (units) per semester and are expected to strive for excellence in teaching, be actively engaged in scholarly activities, including research, and contribute to the governance of the Department. The salary range is \$28,884-\$39,924 for an Assistant Professor and \$28,884-\$55,452 for a Lecturer.

California State University, Chico enrolls 16,000 students, with thirty fulltime faculty in mathematics and statistics. Chico, a community of 60,000, is 90 miles north of Sacramento.

Qualified candidates should submit a resume, graduate transcripts, supporting documents, and at least three letters of recommendation, prior to the closing date of February 1, 1990, to:

Thomas A. McCready, Chair
Department of Mathematics and
Statistics

California State University, Chico
Chico, CA 95929-0525

CSU, Chico is an EO/AA/IRCA employer.

XAVIER UNIVERSITY CINCINNATI, OHIO

Applications are invited for tenure track positions in mathematics/computer science beginning September 1990. Candidates must have an earned doctorate and a commitment to teaching a variety of undergraduate math and C.S. courses within the framework of a Jesuit liberal arts institution. The position also requires advising majors and assisting in course and curriculum revision while continuing a program of scholarly development. Applications will be reviewed as they are received and will be accepted until the positions are filled. Send resume, transcripts and three letters of reference to: D. C. Trunnell, Chair, Mathematics & Computer Science, Xavier University, 3800 Victory Pkwy., Cincinnati, Ohio 45207.

Equal Opportunity/Affirmative Action Employer

LOUISIANA TECH UNIVERSITY DEPARTMENT HEAD MATHEMATICS AND STATISTICS

Louisiana Tech University invites applications for Head, Department of Mathematics and Statistics. The Department of Chemistry, Mathematics and Statistics, and Physics make up the School of Science within the College of Arts and Sciences. The Department Head has responsibility for all facets of departmental activity, which include curriculum development, budgeting, recruiting, scheduling, and faculty evaluation. As the Department's chief administrative officer, he/she will report to the Dean of the College through the Director of the School. The Department is comprised of approximately twenty-five full-time faculty members. Salary is commensurate with qualifications. The position will be available on/after July 1, 1990.

Applicants must hold a Ph.D. in Mathematics or Statistics, have an established record of research and scholarly activity, and be able to provide strong academic leadership.

Although applications will be accepted until the position is filled, evaluation of applicants will begin immediately following the joint meetings in Louisville (a representative will be registered at the meeting). Please submit application, resume, and three letters of reference to:

Dean
College of Arts and Sciences
Louisiana Tech University
Ruston, LA 71272

An Affirmative Action/Equal Opportunity Employer

ST. MARY'S COLLEGE of California Mathematical Sciences

One tenure-track assist. professorship, beginning fall 1990. A Ph.D. and a commitment to both liberal arts education and continued research are expected of candidate to join a young, growing department. Computer science expertise is desirable. St. Mary's is a coeducational college of over 3800 students, located 10 miles east of Berkeley. Current salary range is \$28,786-\$34,259.

Send resume and 3 letters of recommendation, at least 1 of which discusses teaching ability, to Charles Hamaker, Chair, Dept. of Mathematical Sciences, P.O. Box 3517, St. Mary's College, Moraga, CA 94575. Evaluation of candidates will begin February 12, 1990, and continue until the position is filled. Interviews will be held at the AMS meeting in Louisville, KY, January 1990. An EOE/AA employer.

UNIVERSITY OF ARIZONA DEPARTMENT OF MATHEMATICS TUCSON, ARIZONA 85721

The Mathematics Department at the University of Arizona is happy to announce several positions which will be available beginning Fall 1990.

Tenure track positions. Excellent research record or potential, strong commitment to teaching required. Fields should complement but not duplicate existing department research strengths in algebra, computational science, differential equations, dynamical systems, fluid mechanics, geometry, mathematical physics, nonlinear analysis, nonlinear optics, number theory, probability and statistics.

Postdoctoral fellowships (Research Associate). Applicants with areas of strength in applied mathematics, computational science and nonlinear optics may qualify for Special Center of Excellence Awards. Only candidates with outstanding research records or potential should apply.

The Mathematics Department will also have several visiting positions for next year.

We encourage early application. Deadline date will be February 1, 1990 or whenever positions are filled. Women and minority applicants are especially welcome. Send applications (please include Social Security number if possible) to

Department Head
Department of Mathematics
University of Arizona
Tucson, Arizona 85721.

The University of Arizona is an Equal Opportunity/Affirmative Action Employer.

THE UNIVERSITY OF RHODE ISLAND

Lecturer, Mathematics

Teach three courses per semester, perform other duties as assigned by the department chair. PhD in Mathematics (or near completion) required. Preference given to applicants who are current and active in areas compatible with those of the department. One or two year appointments. Submit a letter of application, vita, and three reference letters by February 20, 1990 to:

Barbara Kaskosz, Search Committee
Chair
Lecturer, Mathematics (020430)
Position
The University of Rhode Island
P.O. Box G
Kingston, RI 02881

An Affirmative Action/Equal Opportunity Employer

POSITIONS AVAILABLE

MISSISSIPPI STATE UNIVERSITY

Department of Mathematics and Statistics

Applications are invited for two or more anticipated tenure-track or visiting positions for 1990-91. At least one of the positions will be in statistics and probably at least at the associate professor level. Candidates should possess a doctoral degree, demonstrate a strong potential for research, and have a commitment to effective teaching. All areas are welcomed but preference will be given to the following: for the mathematics position(s), applied mathematics, computational mathematics, and partial differential equations; for the statistics position(s), multivariate analysis, non-parametric and robust inference, categorical analysis, and linear and non-linear models.

The Department offers graduate programs leading to the Master of Arts degree (M.A.) and the Master of Science degree (M.S.) in both mathematics and statistics and the Doctor of Philosophy degree (Ph.D.) in mathematical sciences. Facilities exist for applicants with interest in interdisciplinary research efforts and in particular for applicants with an interest in the computational aspects of the mathematical sciences.

Applicants should send a curriculum vitae and arrange for three letters of recommendation to be sent to: John R. Gilbert, Chairman, Search Committee, Department of Mathematics and Statistics, P.O. Drawer MA, Mississippi State, MS 39762. The committee will begin to review applications on January 15, 1990, and continue until positions are filled. Mississippi State University is an equal opportunity/affirmative action employer.

UNIVERSITY OF WYOMING

Department of Mathematics

Invites applications for the following positions:

One tenure-track position at the assistant professor level in the area of functional analysis, numerical linear algebra, dynamical systems theory, and algebraic/computational combinatorics.

Send resume and direct three letters of recommendation to:

Professor W. Bridges, Chairman
Mathematics Department
P.O. Box 3036 University Station
University of Wyoming
Laramie, WY 82071-3036
(307) 766-4222

Applications completed by January 31, 1990 will be given first consideration. The University of Wyoming is an Equal Opportunity/Affirmative Action Employer.

THE VIRGINIA MILITARY INSTITUTE Mathematics/Computer Science

Applications are invited for a tenure-track position in the Mathematics and Computer Science Department beginning August, 1990. The applicant should have a strong interest in teaching and participating in the continued development of the computer science degree program. VMI began offering a B.S. in computer science in 1987 and now has 57 students either as majors or minors. The computer science laboratory contains a Data General MV/7800 with 20 terminals. VMI also has a Burroughs A9 and approximately 200 IBM PC's for student and faculty use.

Preference will be given to an applicant with a Ph.D. in a computer-related field such as Computer Science, Mathematics, Operations Research, or Management Information Systems. If the degree is not in Computer Science, the applicant must have significant formal education or experience in Computer Science. Duties include teaching both mathematics and computer science courses. Salary and rank are commensurate with degrees, qualifications, and experience.

VMI is a quality undergraduate military college of engineering, liberal arts, and science, with an enrollment of 1300 students, located in an attractive college town. Faculty wear uniforms but have no other assigned military duties.

The deadline for applications is March 1, 1990. Candidates should send resumes with at least three references to Thomas C. Lominac, Department of Mathematics and Computer Science, Virginia Military Institute, Lexington, VA 24450

AA/EEO Employer.

POTSDAM COLLEGE

Mathematics: Potsdam College of the State University of New York invites applications for two positions, one full-time tenure track, one a full-time temporary position in Mathematics commencing September 1, 1990. Responsibilities: Teach at most, 12 hours of undergraduate and beginning graduate mathematics. Qualifications: Ph.D. in Mathematics (any area). Near completion of A.B.D. will be considered. Salary: Commensurate. Send letter of application, resume, graduate transcripts and 3 letters of reference to: Dr. A. Spencer, Department of Mathematics, Potsdam College, Potsdam, NY 13676. Application review will commence February 1, 1990 and continue until the position is filled. Potsdam College is committed to providing opportunities for women and minorities and actively seeks these candidates. EOE/AA

UNIVERSITY OF COLORADO AT BOULDER INSTRUCTORS-VISITING ASSISTANT PROFESSORS PROGRAM IN APPLIED MATHEMATICS

The University of Colorado at Boulder has made a substantial commitment to building a preeminent program in applied mathematics. The program fosters interdisciplinary activities and exciting opportunities exist for interaction with various centers.

Applications are invited for instructors and visiting assistant professor positions beginning in the fall of 1990. Preference will be given to candidates with a research emphasis in any of the following three areas: computational mathematics, physical applied mathematics, especially fluids and plasmas, or nonlinear phenomena.

The Program, an interdisciplinary effort, includes faculty in computer science, engineering, mathematics, astrophysical sciences as well as other departments, institutes and centers.

The University of Colorado has a strong institutional commitment to the principle of diversity in all areas. In that spirit we are particularly interested in receiving applications from a broad spectrum of scholars including women, members of ethnic minorities and disabled individuals.

Applicants should send a current curriculum vitae, reprints, and three letters of recommendation to Professor Mark J. Ablowitz, Director, Program in Applied Mathematics, Campus Box 426, University of Colorado at Boulder, CO 80309-0426. Applications are due February 1, 1990. Applications for positions remaining unfilled will be considered until April 15, 1990. EOE/AA.

PACIFIC LUTHERAN UNIVERSITY

Tenure track position beginning September 1990. Teach 6 undergraduate courses per academic year. Ph.D. in mathematics, mathematical statistics or equivalent required. Have commitment to quality teaching and scholarship. A one or two semester sabbatical replacement position may also be available. Send vita, college transcripts, 3 letters of recommendation (with at least one comment on teaching ability), and if possible, student teaching evaluations to James Brink, Chair, Department of Mathematics and Computer Science, Pacific Lutheran University, Tacoma, Washington 98447. Applications accepted until Jan. 26, 1990 or until position(s) are filled. Pacific Lutheran University embraces the spirit of Equal Opportunity and Affirmative Action and actively encourages applications from women and ethnic minorities.

POSITIONS AVAILABLE

WESTERN WASHINGTON UNIVERSITY

Applications are invited for tenure-track and visiting positions to begin Fall 1990. Successful candidates will be expected to be active in research, to interact at the research level with current department members, and to be good teachers. A Ph.D. in Mathematics is required.

Candidates are especially sought in the following two areas, although outstanding candidates with other specialties will be considered: (1) Applied mathematics. (2) Mathematics Education.

Rank and salary are open, but a substantial research record will be required for appointment above the Assistant Professor level. The normal teaching load for research faculty is two courses per quarter.

Western Washington University is located on Bellingham Bay in an area of outstanding natural beauty within an hour's drive of the Seattle and Vancouver, B.C. metropolitan areas and the Cascade Mountains. The department has a strong undergraduate program with a somewhat applied flavor and a flourishing Master's program with more than twenty students.

Applications should be sent to Professor Thomas T. Read, Chairman, Department of Mathematics, Western Washington University, Bellingham, WA 98225.

Interested candidates should submit a letter of application, complete transcripts, a vita, and three letters of recommendation. Deadline for applications is February 1, 1990; later applications will be considered if positions remain available. Positions are subject to the continuing availability of funds. The University is an EO/AA employer.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY MATHEMATICAL PHYSICS

The Center for Transport Theory and Mathematical Physics at Virginia Tech anticipates a number of openings for visitors during academic year 1990-91. Applications in all areas of mathematical physics are invited for all or any parts of the year. There may also be possibilities of tenure-track appointments. Appointments may be made at any level, from postdoctoral up. Please send a curriculum vitae and a short description of research plans (for visiting positions only) and arrange for three letters of recommendation to be sent directly to Prof. P. F. Zweifel, Virginia Polytechnic Institute and State University, CTMP-212A Robeson Hall, Blacksburg, VA 24061-0435, USA. VA Tech is an EO/AA employer. Women and minorities are encouraged to apply.

UNIVERSITY OF COLORADO AT BOULDER FACULTY APPOINTMENTS PROGRAM IN APPLIED MATHEMATICS

The University of Colorado at Boulder has made a substantial commitment to building a preeminent program in applied mathematics. The program fosters interdisciplinary activities and exciting opportunities exist for interaction with various centers and institutes in the area.

A number of faculty appointments are anticipated over the next few years. Preference will be given to candidates at the Assistant Professor level with a research emphasis in the area of computational mathematics. Exceptionally strong candidates at other levels will be considered. Other areas of foci in the program are nonlinear phenomena and physical applied mathematics, especially fluids and plasmas.

Applicants are invited for tenure track positions with appointments beginning fall, 1990.

The University of Colorado has a strong institutional commitment to the principle of diversity in all areas. In that spirit we are particularly interested in receiving applications from a broad spectrum of scholars including women, members of ethnic minorities and disabled individuals.

Applicants should send a current curriculum vitae and selected reprints to Professor Mark J. Ablowitz, Director, Program in Applied Mathematics, Campus Box 426, University of Colorado, Boulder, CO 80309-0426. Applications are due by February 1, 1990. Late applications will be considered for any positions remaining unfilled on April 15, 1990. EOE/AA.

UNIVERSITY OF NORTHERN IOWA

The Mathematics and Computer Science Department invites applications for a new tenure-track position at the Assistant or Associate Professor level from individuals with a strong commitment to undergraduate teaching. Qualifications include a doctorate in an area of statistics, demonstrated success in collegiate teaching, and scholarly performance or promise. To be assured of full consideration, applications must be received by February 9. For complete announcement, contact Dr. David Duncan, Head, Department of Mathematics and Computer Science, University of Northern Iowa, Cedar Falls, Iowa 50614. Immigration status of non-U.S. citizens must be stated in applications. UNI is an equal opportunity educator and employer with a comprehensive plan for affirmative action. The university specifically invites and encourages applications from minority persons and women.

ALMA COLLEGE

The Department of Mathematics and Computer Science invites applications for a tenure-track position beginning Fall, 1990. Candidates should enjoy teaching a variety of undergraduate mathematics courses in a liberal arts environment and working with students on independent projects. A Ph.D. in Mathematics is required, excellence in teaching is paramount, and the ability to teach some computer science is preferred.

Located in the center of lower Michigan, Alma College is a selective, private college known for the quality of its programs in the sciences and the liberal arts. Alma is a member of the Undergraduate Science Group, a consortium of 50 liberal arts colleges with exceptionally strong science programs. The Department of Mathematics and Computer Science comprises 8 full-time faculty and graduates 10 to 20 majors each year. The normal teaching load is 6 courses per year; faculty development is encouraged. Salaries are competitive and fringe benefits are excellent.

Applications from women and minorities are especially encouraged. Please send a cover letter addressing scholarly interests, resume, graduate transcript, and three letters of recommendation including evaluation of teaching ability to

John Putz

Department of Mathematics and
Computer Science

Alma College

Alma, Michigan 48801

by February 2, 1990. Alma College is an AA/EO employer.

OCCIDENTAL COLLEGE

Occidental College, Los Angeles, California 90041 has an opening for a full-time regular appointment beginning in September 1990. Appointment is open to rank. Ph.D. and expertise in statistics required. Excellence in teaching and quality research is expected. Two courses (8 hours per week) per quarter of teaching except during the first year of appointment when only five courses are taught. Occidental is a selective four-year liberal arts college. Candidate will interact with social science students and faculty on matters of mutual interest. The college actively supports affirmative action. Applications from ethnic minorities and women are strongly encouraged. Interviews will be held at the January AMS meeting. Send resume and three letters of recommendation (one about teaching) to Statistics Search Committee, Department of Mathematics, Occidental College, 1600 Campus Road by February 15, 1990.

POSITIONS AVAILABLE

GMI ENGINEERING & MANAGEMENT INSTITUTE FACULTY POSITION IN MATHEMATICS

The Science and Mathematics Department of GMI Engineering & Management Institute is seeking to fill a tenure-track position in mathematics at the level of Assistant Professor. Outstanding candidates may be considered for appointment at the rank of Associate Professor or the rank of tenured, Full Professor.

GMI is a highly competitive private college whose academic year starts July 1. The Mathematics faculty consists of 14 full-time members, who offer a wide range of undergraduate courses. The feasibility of initiating a degree program in mathematics or computer science is currently under investigation.

The minimum requirements for this position include an earned Ph.D. in mathematics or a related field and evidence of strong research and undergraduate teaching abilities. Areas of expertise of special interest include mathematics applied to engineering disciplines, mathematics education, actuarial mathematics, and computer applications.

Please send resume, statement concerning current research interests, and three letters of reference to: Dr. J. J. Salacuse, Search Committee Chair, Science and Mathematics Department, GMI Engineering & Management Institute, 1700 West Third Avenue, Flint, Michigan 48504-4898. Applications will be accepted until February 1, 1990 or until the position has been filled.

GMI is an Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE DEPARTMENT OF MATHEMATICS, CHARLOTTE, NC 28223

Two tenure-track and one or more Visiting positions at Asst/Assoc/Full Prof. level in Mathematics and Statistics, and one senior Assoc/Full Prof. level in Math Education. Rank and salary depend on qualifications. A Ph.D. and a serious commitment to teaching and research are required. Preferred specialties are: Algebra, Analysis, Applied Mathematics, Math Education, Statistics, but strong candidates in all areas are encouraged to apply. Also possible are lecturer positions (one or two year renewable; MA/MS required). Send vitae, list of four references, and abstracts of current research to Prof. Hae-Soo Oh at the above address. Closing date: Feb. 2, 1990, but applications will be considered until the positions are filled.

UNCC IS AN AFFIRMATIVE ACTION/
EQUAL OPPORTUNITY EMPLOYER

WAKE FOREST UNIVERSITY The Z. Smith Reynolds Professorship in Mathematics

Wake Forest University announces the establishment of a distinguished professorship made possible by the Z. Smith Reynolds Foundation. The scholar selected to fill this position must have an established record of recognized scholarship and a commitment to teaching and research in a university setting. Duties include teaching, continuing a program of research, contributing to the intellectual life of the Department of Mathematics and Computer Science, and fostering the mathematical growth of gifted undergraduates. The position, which carries both tenure and the rank of professor, could be filled as early as the fall semester of 1990.

Wake Forest University is a comprehensive university with 5000 students, 3500 of whom are in the undergraduate college. The Department of Mathematics and Computer Science has 17 permanent positions, 13 of which are in mathematics, and offers majors in mathematics and computer science and an MA in mathematics.

Inquiries, nominations, and applications should be directed to:

Professor Richard Carmichael, Chair
Department of Mathematics and
Computer Science
P.O. Box 7311
Wake Forest University
Winston-Salem, NC 27109 USA

Evaluation of applicants will begin in late winter and will continue until the position is filled. AA/EO employer.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY DEPARTMENT OF MATHEMATICS

We anticipate making several tenure-track appointments at the assistant professor level or above beginning with the academic year 1990-1991. Very strong research potential is required for junior-level appointments and a demonstrated outstanding record for senior-level appointments. A Ph.D. is required. Primary areas of interest are algebraic and differential geometry, discrete mathematics, dynamical systems, and computationally oriented mathematics. Exceptional candidates in other areas will be considered. Applications will be accepted until March 15, 1990, or until the positions are filled. Applicants should send vita and three letters of reference to: Chairman, Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24016-0123. Women and minorities are encouraged to apply. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF NORTHERN COLORADO Senior Position

The Department of Mathematics & Applied Statistics is making mathematics education reform a major emphasis. In this direction we have recently received approval for a Ph.D. degree in Educational Mathematics. This program assumes that mathematical content is the pre-eminent concern in developing educational strategies necessary for the improvement of mathematics education.

The University is seeking an individual at the Associate/Full Professor level to provide leadership in obtaining grants for the reform of teaching of mathematics. The individual would be expected to participate in the continuing development of the new Ph.D. in educational mathematics and to continue on an active scholarly program. Teaching assignment is negotiable.

Applicants should possess a Ph.D. in mathematics or a closely related field, a history of funded grants especially for research in teaching of mathematics, and a solid record of publications. Send a letter of application, a candidate statement of U.S. citizenship, eligibility for U.S. employment, curriculum vitae, and three letters of recommendation to: Dr. Don Elliott, Search Committee Chair, Department of Mathematics & Applied Statistics, University of Northern Colorado, Greeley, CO 80639.

Initial screening will begin February 1, 1990. Applications will be considered until the position is filled. UNC is an AA/EO Employer: This tenured/tenure-track position is contingent upon State funding.

GOUCHER COLLEGE MATHEMATICS AND COMPUTER SCIENCE DEPARTMENT

Applications are invited for two tenure-track positions at the Assistant Professor level beginning August, 1990. Qualifications include a Ph.D. in mathematics or computer science and a strong commitment to and demonstrated excellence in undergraduate teaching. Responsibilities include a teaching load of 9-10 hrs/wk and continuing scholarly activity. Goucher is a select, private, coeducational liberal arts college located eight miles from Baltimore and is convenient to Washington, D.C. The selection process will begin in February 1990. Goucher is an EOE. Send vita and three letters of recommendation to:

Dr. Joan S. Morrison
Chair of the Mathematics and
Computer Science Department
Goucher College
Towson, MD 21204

POSITIONS AVAILABLE

CARTHAGE COLLEGE

Carthage will make a tenure-track appointment to a generalist in mathematics who has an emphasis in statistics or analysis, and whose primary commitment is undergraduate teaching. The College also encourages, and will support, research and active engagement in professional activities.

Carthage is experiencing growing enrollments and rising test scores in the entering classes. The College will need to make a number of new faculty appointments in the near future. Carthage seeks someone willing to participate imaginatively in developing the curriculum and in shaping the future of mathematics and the natural sciences at the College.

Located on the shores of Lake Michigan between Chicago and Milwaukee, Carthage offers easy access to major urban areas. Totaling almost 2000 full and part-time students, the student body is drawn primarily from the Midwest but includes students from more than twenty states and a variety of foreign countries.

Salary and benefits are competitive, based on academic credentials and experience; we will be interviewing at the Louisville meetings. Please send nominations and applications, with a current curriculum vitae, to Charlotte J. Chell, Chair, Department of Mathematics, Carthage College, Kenosha, WI 53140-1994. EOE/AA

UNIVERSITY OF CALIFORNIA SANTA BARBARA Department of Mathematics

Applications are invited for a ladder-position at the Assistant Professor level in the area of nonlinear partial differential equations, including the numerical and applied aspects thereof. Salary will depend upon qualifications. Appointment will be effective July 1, 1990. Candidates must possess the Ph.D. degree or equivalent. Strong evidence of commitment to teaching and outstanding promise in research is required. To apply send vita and publication list, and arrange to have letters of recommendation sent to: PDE Search Committee, Department of Mathematics, University of California, Santa Barbara, CA 93106. Deadline to apply is January 15, 1990.

UCSB is an Equal Opportunity/Affirmative Action Employer. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Reform and Control Act of 1986).

HOBART AND WILLIAM SMITH COLLEGES Department of Mathematics and Computer Science

Assistant Professor, tenure track position starting in September 1990. Salary is competitive. Applicants should have a Ph.D. in computer science or a Ph.D. in mathematics and experience in computer science. Duties include teaching undergraduate computer science, teaching some mathematics (depending on interests and qualifications), and participating in the Colleges' Interdisciplinary General Curriculum. A strong commitment to teaching and promise of continued scholarly activity required. Teaching load: two courses per trimester. Hobart and William Smith are coordinate, four year, liberal arts colleges, committed to teaching and interdisciplinary study with a combined enrollment of 1900 students. Within an hour's drive are three major universities: Cornell, Rochester, and Syracuse.

Send detailed resume, three letters of recommendation (at least one including comments on teaching), and undergraduate and graduate transcripts (photocopies acceptable) to: Prof. David Eck, Department of Mathematics and Computer Science, Hobart and William Smith Colleges, Geneva, NY 14456. Evaluation of applications will begin January 15, 1990 and will continue until the position is filled. Women and minorities are encouraged to apply. An Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF PITTSBURGH Department of Mathematics and Statistics

The following positions are expected, subject to funding approval:

1. Specialist in applied mathematics with emphasis on scientific computing.
2. A position in pure mathematics. We are interested particularly in algebraic topology, algebra, and analysis, but outstanding applicants in any field will be considered.

The rank is open on each position. Requirements include outstanding research accomplishment or potential. Excellence in teaching is also essential.

Junior applicants should send a resume and arrange to have at least three letters of recommendation sent to: Stuart Hastings, Department of Mathematics and Statistics, University of Pittsburgh, Pittsburgh, PA 15260. Senior applicants should write directly to the same address.

The University of Pittsburgh is an equal opportunity/affirmative action employer. Women and minorities are especially encouraged to apply.

RICE UNIVERSITY Mathematical Sciences Department P.O. Box 1892, Houston, Texas 77251

Applications are invited for a tenure-track assistant professor position to start August, 1989 in energy and environmental applications of mathematics. Applicants should demonstrate both breadth of interest and promise in research and teaching. We especially invite applications in numerical linear algebra, mathematical programming, and numerical solutions of partial differential equations.

Rice University is a private research university with a long tradition of excellence in undergraduate science and engineering education. The Mathematical Sciences Department also hosts an active and expanding graduate program, has superb computing facilities and ongoing research in Operations Research, Computational Mathematical Programming, and Optimal Design and Inverse Problems for Partial Differential Equations. The department has excellent relations with other departments at Rice and the University of Houston, with industrial and governmental research groups, and is actively involved in the Center for Research in Parallel Computation which is funded by the NSF Science and Technology Centers program.

Please furnish vita, transcripts, reprints, and three letters of recommendation to J. E. Dennis, Chair, Staffing Committee. Rice University is an Affirmative Action/Equal Opportunity Employer.

THE UNIVERSITY OF ALABAMA MATH FACULTY POSITIONS

The department expects to fill from two to five tenure track positions at the rank of Assistant Professor or possibly at a higher rank beginning August 16, 1990. Areas of special interest are: algebra, analysis, fluid mechanics, computational mathematics, differential equations, differential geometry, optimization, stochastic modeling, and topology. Applicants for Assistant Professor should have or reasonably expect to have by August 16, 1990 a Ph.D. or the equivalent. Excellence in both teaching and research is required. An established record of research and leadership in one of the areas described above is expected of applicants for a senior position. We also invite applications for visiting positions. Women and minorities are particularly encouraged to apply. Send a curriculum vitae, reprints and/or preprints, and at least three letters of recommendation to: Search Committee, Department of Mathematics, The University of Alabama, Box 870350, Tuscaloosa, AL 35487-0350. UA is an AA/EOE.

POSITIONS AVAILABLE

TRINITY COLLEGE Hartford, CT

The Department of Mathematics at Trinity College invites applications for one tenure-track position and for one or more visiting positions, which will begin in the academic year 1990-91. The normal teaching load is five semester courses per year ("3/2"). Rank and salary are open, and dependent on qualifications. Specialization is also open. Requirements for the positions: Ph.D. in mathematics, evidence of teaching excellence at the undergraduate level, and (for the tenure-track job) indications of promise in research.

Applicants should send a c.v., three letters of reference (at least one of which speaks directly to teaching experience), and a statement of teaching and research interests to

Search Committee Chair
Dept. of Mathematics
Trinity College
Hartford, CT 06106

by February 1, 1990.

Representatives of the department will attend the Employment Register at the joint Annual Meetings in Louisville in January, 1990.

Applicants will be considered for both the tenure-track and visiting positions unless they specify otherwise.

Trinity College is an Equal Opportunity/Affirmative Action employer. Women and members of minority groups are especially encouraged to apply.

ALLEGHENY COLLEGE Mathematics Department Meadeville, PA 16335

Receiving applications for a tenure-track position beginning September 1990. Applicants should have a Ph.D. in mathematics, commitments to the teaching of undergraduate students and to continued professional development. Rank and salary are competitive and commensurate with qualifications and experience. Fringe benefits include TIAA-CREF, health and life insurance, full tuition benefits for family, and personal computers in faculty offices.

Screening of applicants will begin January 4 and continue until the position is filled. Send application, vita, graduate transcripts, and three letters of recommendation to Dr. Ronald Harrell, Search Committee Chairman. Early applicants should also indicate whether they plan to attend the Joint Mathematics Meetings in Louisville, KY. Allegheny College is an Equal Opportunity Employer.

MISSISSIPPI STATE UNIVERSITY ADVERTISEMENT

Position Announcement Head, Department of Computer Science

Mississippi State University invites applications and nominations for the position of head of the Department of Computer Science. A successful candidate must have (1) an earned doctorate in computer science or related field, an (2) faculty experience in a doctoral granting program. In addition, candidates should have demonstrated leadership and a successful record of teaching, research, and grant procurement. The appointment will be at the rank of professor with a highly competitive salary. The anticipated starting date is July 1, 1990.

As one of the 100 largest research universities (expenditures) in the country and the largest university in the state, MSU offers a broad range of undergraduate and graduate programs. The Department of Computer Science offers a CSAB-accredited undergraduate program and graduate study leading to the MCS, MS and PhD degrees. In cooperation with electrical engineering, the department also offers programs of study leading to the BS and MS degrees in computer engineering.

Screening of candidates will begin February 15, 1990 and will continue until the position is filled. Nominations and applications with curriculum vita should be sent to: Dr. George S. Rent, Chairperson, Search Committee for Head of Computer Science, College of Arts and Sciences, P.O. Box AS, Mississippi State, MS 39762. MSU is an equal opportunity affirmative action employer.

NORTHWESTERN UNIVERSITY MATHEMATICS DEPARTMENT 2033 Sheridan Road Evanston, Illinois 60208-2730

The Mathematics Department invites applications for a tenure-track position at the level of Assistant Professor from mathematicians with strong research interests. Preference will be given to those areas which complement the present department strengths. Applications should include a curriculum vitae (including a list of publications) and the applicant should have three reference letters sent to the Chairman, Personnel Committee, Department of Mathematics, Northwestern University, Evanston, Illinois 60208-2730. Northwestern University is an Affirmative Action/Equal Opportunity employer. Hiring is contingent upon eligibility to work in the United States.

GRAND VALLEY STATE UNIVERSITY ALLENDALE, MICHIGAN

Four tenure-track positions are open in the Department of Mathematics and Computer Science beginning Fall, 1990. Preferred specialties are: Math Education, Statistics, Computer Science, and Information Systems. Earned doctorate and strong teaching recommendations are required. Duties include teaching undergraduate and/or graduate courses, student advising and professional development.

The Grand Valley campuses are located in greater Grand Rapids, the second largest metropolitan area in Michigan, offering numerous cultural and recreational opportunities. Cost of living is moderate and quality of life is high. Send resume and three letters of recommendation by February 1, 1990 to the Search Committee, Mathematics and Computer Science Dept., GVSU, Allendale, MI 49401. Applications will be accepted until positions are filled. GVSU is an EO/AAI.

THE UNIVERSITY OF NEW MEXICO

Albuquerque, New Mexico Department of Mathematics and Statistics

The Department expects to have four tenure-track positions available, beginning in the Fall Semester, 1990. We are particularly interested in candidates at the assistant professor level with postdoctoral experience, but will consider outstanding applicants at all levels. Candidates must have a strong research record or outstanding potential and a commitment to excellence in teaching.

The Department of Mathematics and Statistics currently has 40 faculty members, an active and expanding graduate program. The Department has close research ties with Los Alamos and Sandia National Laboratories, and access to major computing facilities. Joint appointments with other departments are possible.

Review of applications will begin January 15, 1990, and will continue until the positions are filled. All exceptionally strong candidates, especially women and minority group members, are urged to apply. Please have three letters of reference sent to:

Professor Robert Cogburn, Chair
Hiring Committee
Dept. of Mathematics & Statistics
The University of New Mexico
Albuquerque, NM 87131

THE UNIVERSITY OF NEW MEXICO
AA/EOE.

POSITIONS AVAILABLE

POMONA COLLEGE CLAREMONT, CA 91711

Pomona College invites applications for a tenure track Assistant Professorship in the mathematical sciences beginning in the fall of 1990. The Ph.D. and demonstrated excellence in teaching and research are required. Must have a strong commitment to high quality teaching in a variety of undergraduate courses and contributing to the mathematical life of our department. Preference will be given to strong candidates in statistics and applied mathematics. Pomona College, the founding member of The Claremont Colleges, offers the opportunity to teach intellectually gifted undergraduates in a small liberal arts college while participating in a mathematically active intercollegiate community of over 30 mathematicians, with clinics in applied mathematics and statistics. Submit applications, including resume, transcripts and letters evaluating teaching and research capabilities by January 31, 1990, to The Search Committee, Department of Mathematics, Millikan Laboratory, Pomona College, Claremont, CA 91711-6348. Applicants who will attend the AMS January Meeting in Louisville should so indicate in their application letter prior to January 3. Pomona College is an affirmative action/equal opportunity employer and encourages applications from minority candidates and women.

UNIVERSITY OF SOUTH CAROLINA Department of Mathematics

Applications are invited for anticipated tenure-track faculty positions at all ranks. Applications in all areas of mathematics will be considered. The Department is building on existing research strengths and is increasing the scope of its program in applied and computational mathematics. Faculty research is supported by excellent departmental library and high-performance computing facilities. The Ph.D. degree or its equivalent is required, and all appointments will be consistent with the Department's commitment to excellence in research and teaching at the undergraduate and graduate levels. A resume, containing a summary of research accomplishments and goals, and four letters of recommendation should be sent to:

Dr. Colin Bennett, Chairman
Department of Mathematics
University of South Carolina
Columbia, South Carolina 29208

The closing date for applications is January 31, 1990. The University of South Carolina is an Affirmative Action/Equal Opportunity Employer.

CITY COLLEGE OF CUNY

The Department of Mathematics anticipates making one or more tenure track appointments beginning Fall 1990 at the Assistant or Associate Professor level depending upon qualifications. Significant achievements or outstanding potential in research and evidence of excellence in teaching are required. Preference will be given to candidates with at least one year of postdoctoral experience.

Applications are especially invited in fields targeted by the department for development. These include combinatorics, mathematics of computation, modeling, and applied mathematics. Successful candidates will be encouraged to interact with active doctoral programs in the sciences, engineering, and computer science. Exceptional candidates in other areas will also be considered. Women and minority candidates are particularly encouraged to apply.

The closing date for applications is February 1, 1990 but applications will be considered until the position(s) are filled. Applicants should send a resume, including a brief description of current research interests, and have three letters of reference sent to:

Professor Jack Barshay, Chairman
Department of Mathematics
The City College of CUNY
Convent Ave. at 138th Street
New York, New York 10031

An AA/EEO Employer M/F/H/V

ROLLINS COLLEGE Department of Mathematical Sciences Winter Park, FL 32789

At least one and perhaps two visiting positions are available for September, 1990. The approved position is a two-year appointment with renewal possible and the other is a one-year sabbatical replacement. The area of specialization is open. A Doctorate or ABD is preferred, but a masters with teaching experience will be considered. A strong commitment to teaching undergraduates is required. The Department offers majors in mathematics and computer science, is currently engaged in a calculus renewal project (funded by NSF) and is well-equipped with Macintosh II computers. The teaching load is 8-10 hours per week. Winter Park, a delightful city of 40,000, is located in the greater Orlando area. To ensure full consideration, applications must be complete by 15 Feb 1990. Send resume, transcripts and three letters of recommendation (at least one of which must comment on teaching) to: David Kurtz, Chair. Rollins College is an affirmative action/equal opportunity employer and women and members of minority groups are encouraged to apply.

DARTMOUTH COLLEGE John Wesley Young Research Instructorship

The John Wesley Young Research Instructorship is a two year post-doctoral appointment for promising new or recent PhD's whose research interests overlap a department member's. Current departmental interests include areas in algebra, analysis, algebraic geometry, combinatorics, computer science, differential geometry, logic and set theory, number theory, probability and topology. Teaching duties of four ten-week courses spread over two or three quarters typically include at least one course in the instructor's specialty and include elementary, advanced and (at instructor's opinion) graduate courses. Nine-month salary of \$31,000 supplemented by summer (resident) research stipend of \$6,889 (two-ninths). Send letter of application, resume, graduate transcript, thesis abstract, description of other research activities and interests if appropriate, and 3 or preferably 4 letters of recommendation (at least one should discuss teaching) to Richard E. Williamson (Recruiting), Department of Math and CS, Bradley Hall, Hanover, NH, 03755. Applications received by Jan. 15 receive first consideration; applications will be accepted until position is filled. Dartmouth College is committed to affirmative action and strongly encourages applications from minorities and women. EOE/AA.

UNIVERSITY OF CALIFORNIA LOS ANGELES Department of Mathematics

REGULAR POSITIONS IN PURE AND APPLIED MATHEMATICS

Four to six regular positions in pure and applied mathematics. Areas of specific interest include logic; algebra, algebraic geometry, number theory and combinatorics; geometry and topology; analysis, functional analysis, mathematical physics and dynamical systems; probability, statistics and game theory; linear and non-linear differential equations; applied mathematics, numerical analysis and mathematical computer science. Very strong promise in research and teaching required. Positions initially budgeted at the assistant professor level. Sufficiently outstanding candidates at higher levels will also be considered. Teaching load: Averaging 1.5 courses per Quarter, or 4.5 Quarter courses per year.

To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search.

UCLA is an equal opportunity/affirmative action employer.

POSITIONS AVAILABLE

UNIVERSITY OF MANITOBA

Department of Mathematics and Astronomy

invites applications for two tenure-track appointments at the Assistant Professor level, effective July 1, 1990. Salary commensurate with qualifications and experience. Ph.D. completed or near completion required. Applicants must have proven ability or demonstrated potential for both research and teaching. The Department is primarily interested in adding to its expertise in analysis, but it also has an interest in the fields of differential geometry, discrete mathematics, foundations, number theory, algebraic topology. The successful candidates will be expected to teach classes at both the undergraduate and graduate levels.

Both women and men are encouraged to apply. In accordance with Canadian immigration requirements priority will be given to Canadian citizens or permanent residents.

Applicants should send a curriculum vitae to the address below. In addition 3 referees should be requested to send letters of reference directly to: PROFESSOR LYNN BATTEN, HEAD, DEPARTMENT OF MATHEMATICS AND ASTRONOMY, UNIVERSITY OF MANITOBA, WINNIPEG, MANITOBA, R3T 2N2.

The deadline for applications is FEBRUARY 16, 1990.

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM DEPARTMENT OF MATHEMATICS

Applications are invited for one or more anticipated tenure or tenure-track positions. Preference will be given to strong candidates whose research interests are compatible with those of our current faculty; this includes numerical PDE/Scientific computation, mathematical physics, partial differential equations, nonlinear analysis, dynamical systems, including topological dynamics, and differential geometry. Faculty members have access to the Alabama Super Computer (using a Sun Station and a T-1 line to a Cray X-MP/24). Rank and salary will be subject to qualifications, but applicants for senior positions must have demonstrated excellence in research, while applicants for junior positions must exhibit the promise of excellence. Send as soon as possible a curriculum vita, selected reprints, and three letters of reference (candidates for senior positions may choose to submit a list of references instead) to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/Equal Opportunity Employer.

DARTMOUTH COLLEGE

Senior Position in Mathematics. Associate or Full Professor position available beginning in 1990-91. Candidates should have established and recognized research program, proven ability to attract external research support, and interest in building and leading a strong research group. Appointee will participate in the recruitment for several junior positions. Proven record of excellence in teaching at both the undergraduate and graduate levels and commitment to professional interaction with faculty and Ph.D. students required. Applications are welcome in all fields of mathematics. Department has special interests in algebra, combinatorics, geometry/topology, and probability/statistics. Dartmouth provides grants to new faculty members for research-related expenses, a generous sabbatical program, and moderate teaching loads. The review of applications will begin on January 1, 1990. Send a letter of application, a curriculum vitae, the names of four people who have agreed to write letters of recommendation, and a description of research interests to: Mathematics Senior Search Committee Chair, Department of Mathematics and Computer Science, Bradley Hall, Dartmouth College, Hanover, NH 03755. Dartmouth is firmly committed to Affirmative Action and strongly encourages applications from minorities and women.

CALIFORNIA STATE UNIVERSITY SAN BERNARDINO DEPARTMENT OF MATHEMATICS

Applications are being accepted for the position of Assistant Professor or Associate Professor (tenure-track); a Ph.D. in mathematics or mathematics education with at least a bachelor's degree in mathematics is required. Successful candidates will be expected to teach twelve hours per week, participate in scholarly activities, and help implement a new MAT program. Current salary range is \$28,884-\$50,472 dependent upon qualifications and experience. Applicants should submit a letter of application, vita, three letters of recommendation and all transcripts. Applications received after February 1, 1990, cannot be guaranteed consideration. Materials should be sent to:

Dr. John Sarli
Chair, Department of Mathematics
California State University
5500 University Parkway
San Bernardino, California 92407

AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION, SECTION 504, TITLE IX EMPLOYER

UNIVERSITY OF CALIFORNIA, RIVERSIDE TEMPORARY AND VISITING APPOINTMENTS IN MATHEMATICS AND COMPUTER SCIENCE

Subject to final budgetary approval, the Department of Mathematics and Computer Science anticipates being able to make several one-year temporary and/or visiting appointments for 1990-91. Depending on the duties assigned and the qualifications of candidate the rank will be that of Lecturer or Visiting Assistant Professor. Salaries are competitive. All areas of expertise will be considered. Commitment to excellent teaching and instructional experience are required. Successful candidates will be expected to have the Ph.D. in hand at the time of appointment. Minorities and women candidates are particularly urged to apply.

Applications consisting of a curriculum vitae, a statement of interests, and three letters of reference should be submitted by April 1, 1990 to ensure consideration and should be addressed to:

Professor Albert R. Stralka
Chair, Department of Mathematics
and Computer Science
University of California, Riverside
Riverside, CA 92521

UCR is an equal opportunity/Affirmative Action employer.

UNIVERSITY OF CALIFORNIA AT RIVERSIDE Faculty Position in Mathematics

Applications and nominations are invited for a tenure or tenure track position in Geometric Analysis beginning July 1, 1990 or later. The position is open as to rank; candidates at all levels and in all areas of geometric analysis will be considered. Demonstrated excellence in research and teaching is required. The eligibility pool for this position will consist of the candidates for whom we receive a vita, a list of publications and three letters of recommendation by January 22, 1990. Established criteria of the University of California determine salary and rank. Candidates should send a curriculum vita, a list of publications, and the names of at least three references to:

Professor Bun Wong, Chair
Geometric Analysis Hiring Committee
Department of Mathematics and
Computer Science
University of California
Riverside, California 92521

University of California is an Affirmative Action/Equal Opportunity Employer.

POSITIONS AVAILABLE

THE UNIVERSITY OF OKLAHOMA Applied Non-Linear Analysis Applied Mathematics Position (CAPS) Related

The University of Oklahoma seeks a (tenure track) Assistant Professor (or higher) with a speciality in Applied Non-Linear Analysis. A Ph.D. in Mathematics is required. Expertise in fluid dynamics and numerical and computational experience are desirable. Potential for excellence in mathematics teaching and research is required. Competitive Salary.

This position is expected to contribute to the mathematical support of the Center for the Analysis and Prediction of Storms, A Science and Technology Center at the University of Oklahoma funded by the National Science Foundation.

Applicants should send a letter of application, a complete vita, and have three letters of reference sent to: Andy R. Magid, Chair, Applied Analysis Search Committee, Department of Mathematics, University of Oklahoma, 601 Elm, Room 423, Norman, Oklahoma 73019-0315. Closing date for applications is December 20, 1989 and every two weeks thereafter until the position is filled. The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

THE UNIVERSITY OF OKLAHOMA Department of Mathematics

Applications are invited for one or more positions at the Assistant Professor level (or higher) in Mathematics beginning Fall 1990. Candidates must have a Ph.D. degree, demonstrated excellence in research, and potential for high-quality teaching. Strong candidates in all areas will be considered, with preference given to research interests compatible with those of our current faculty. Duties include research, normally teaching six credit hours per semester, and Departmental and University service appropriate to rank. Salary and rank will be commensurate with qualifications and experience. There may also be visiting positions. Applicants should send their vita and have at least three letters of reference sent to Dr. Ruediger Landes, Search Committee Chair, Department of Mathematics, University of Oklahoma, 601 Elm, Room 423, Norman, Oklahoma 73019-0315. Initial screening begins December 15, 1989 and every two weeks thereafter. Applications will be accepted until the position(s) are filled. The University of Oklahoma is an Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF CALIFORNIA MATHEMATICS DEPARTMENT SANTA CRUZ, CA 95064

The Mathematics Department at the University of California, Santa Cruz expects to have several visiting positions available during the academic year 1989-90 and invites applications from qualified mathematicians in all fields. Appointments will be made as Visiting Assistant, Associate or Full Professor, as appropriate. Visitors will be expected to teach, pursue their research, and perform some department or university service. Such positions are available for periods ranging from one quarter to the full academic year, with a possible extension to a second year. There is also a possibility that visitors will be able to stay on to do summer school teaching following the academic year. Preference will be given to those who can teach for the entire academic year. Applicants must hold the Ph.D. in Mathematics. University teaching experience desired. Applicants should send vitae, three letters of reference speaking of the applicant's teaching and research experience to: Recruiting Committee, Mathematics Department, University of California, Santa Cruz, CA 95064. Closing Date: February 1, 1990. Please refer to #T89-14 in your reply. UCSC is a SAA/EOP/IRCA/EOE/AA employer.

THE UNIVERSITY OF WEST FLORIDA

Applications are invited for three tenure-track positions beginning Fall, 1990. Two positions are at the assistant professor rank, one will be at the associate or assistant professor rank. The Ph.D. is required for all positions. Areas of specialization needed are applied mathematics (computational mathematics and applications and/or operations research) and statistics (applied statistics, statistical quality control and/or operations research). One position is reserved for a candidate with expertise in operations research. A record of excellent teaching and research is required for the associate professor rank. Applications from minorities and women are especially encouraged. Duties normally consist of teaching three courses per semester (9-10 hours), advising, research, and service. Persons interested in applying for one of these positions should send a vita and arrange for three letters of reference to Dr. Shawky E. Shamma, Chairman, Search Committee, Department of Mathematics and Statistics, The University of West Florida, Pensacola, FL 32514. Screening begins February 1, 1990.

An affirmative action/equal opportunity employer.

UNIVERSITY OF CENTRAL FLORIDA Department of Mathematics

Applications are invited for at least five tenured track and visiting positions at Associate, Assistant Professor or instructor level beginning in August 1990. Ph.D. degree with strong research potential or experience and dedication to teaching required for appointment at Associate or Assistant Professor level. Candidate with substantial completion of Ph.D. requirements will be considered for the instructor level. The positions are unrestricted as to area of specialization within mathematical sciences. For one of the tenured track positions preference will be given to those with research interests in numerical analysis, computational mathematics or related applied fields. Candidate should send a detailed resume and arrange to have at least three letters of recommendation and a transcript sent to: Dr. Lokenath Debnath, Department of Mathematics, University of Central Florida, Orlando, Florida 32816, postmarked by February 2, 1990. Some Search Committee members will be available at the Louisville meeting in January 1990 for an interview. The University is an equal opportunity affirmative action employer. As an agency of the State of Florida, UCF makes all application materials and selection procedures available for public review.

WEST VIRGINIA UNIVERSITY Department of Mathematics

The Department of Mathematics intends to make several faculty appointments that will commence August 1990. Appointments are expected to be made at the Assistant or Associate rank. Candidates are expected to have a PhD in mathematics or equivalent with a strong record or demonstrated potential in both research and teaching. Preference will be given to applicants whose research interests complement those currently in the Department in algebra, analysis, applied or numerical analysis, discrete mathematics. Normal responsibilities include research and a two course teaching assignment per semester at the graduate or undergraduate level. Applications and inquiries should be directed to James Lightbourne, Department of Mathematics, West Virginia University, Morgantown, WV 26506. Applicants should submit a vita and have three letters of reference sent (senior applicants may choose to submit names of references). Applications will be reviewed beginning January 15, 1990. WVU is an affirmative action/equal opportunity employer. Qualified women and minorities are especially encouraged to apply.

POSITIONS AVAILABLE

MURRAY STATE UNIVERSITY Department of Mathematics & Statistics

Applications are invited for tenure-track positions at the Assistant/Associate Professor level beginning August 1990. Preference will be given the applicants in statistics, numerical analysis, and mathematics education, but candidates in all areas of mathematics will be considered.

Responsibilities will include a maximum three course teaching load of a wide variety of undergraduate and graduate level courses, continuing research/scholarly activities, and university/departmental service. A Ph.D. in mathematics or statistics is required or expected before the starting date. Salary will be competitive. Screening will begin February 1, 1990 and continue until positions are filled.

Applicants who are not U.S. citizens must provide their visa status and any other information relevant to their ability to accept employment. Send letter of application with vita, graduate transcript or list of courses, and direct three letters of recommendation to:

Screening Committee
Department of Mathematics & Statistics
Murray State University
Murray, Ky. 42071

MSU is an EO/AA employer.

AUBURN UNIVERSITY DEPARTMENT OF ALGEBRA, COMBINATORICS AND ANALYSIS

The department expects to make two tenure-track appointments at the rank of assistant professor beginning September 1990. One position is in any area of probability theory. One position is in combinatorics with preference given to candidates in coding theory or cryptography.

Some temporary one-year appointments at the rank of assistant professor are also expected for September 1990. For these, research interests compatible with current faculty in algebra, analysis, combinatorics, differential equations, linear algebra or probability desired.

Excellence required in both teaching and research for all positions. Send resume and arrange for at least three letters of recommendation to be sent to James Wall, 120 Math Annex, Auburn University, AL 36849-5307. Minorities and women are encouraged to apply. AUBURN UNIVERSITY IS AN EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER.

UTAH STATE UNIVERSITY

Department of Mathematics and Statistics

Applications and nominations are invited for tenured or tenure-track positions in mathematics and statistics beginning September, 1990. Applications in all areas and at all ranks will be considered.

Excellence in research and a demonstrated commitment to both graduate and undergraduate teaching are required. Successful applicants in applicable areas will be expected to interact with the mathematics, statistics and applied science faculty at USU. The ability to provide broad scholarly leadership is essential for senior-level applicants.

Utah State University, located in the Wasatch Range of the Rocky Mountains, offers competitive salaries and excellent medical, retirement and professional benefits.

Applications, including resume and three letters of reference, should be submitted to: Search Committee, Department of Mathematics and Statistics, Utah State University, Logan, UT 84322-3900. Preference will be given to applications completed by January 31, 1990, but all will be considered until available positions are filled.

Utah State University is an equal opportunity/affirmative action employer.

CASE WESTERN RESERVE UNIVERSITY DEPARTMENT OF MATHEMATICS AND STATISTICS

Tenure-track, possibly senior, positions anticipated to begin August 15, 1990. Outstanding research record and/or proven research potential and teaching excellence required. Preferred areas: Statistics and Probability. The recently established CWRU Center for Stochastic and Chaotic Processes in Science and Technology will provide an especially friendly environment for probabilists doing theoretical research motivated by serious applications. Interacting particle systems, stochastic control, population genetics, random media and infinite dimensional stochastic processes (Malliavin calculus and stochastic P.D.E.) are good examples here. The statisticians are expected to work within an autonomous Applied Statistics unit. Women and minority groups candidates are especially encouraged to apply. Visiting positions also possible. Send vita plus three letters of recommendation to Professor W. A. Woyczynski, Chairman, Department of Mathematics and Statistics, Case Western Reserve University, Cleveland, OH 44106.

An affirmative action equal opportunity employers.

UTAH STATE UNIVERSITY

Department of Mathematics and Statistics

Applications and nominations are invited for tenured or tenure-track positions in nonlinear partial differential equations and/or dynamical systems, beginning September, 1990. Applications for all ranks will be considered.

Excellence in research and a demonstrated commitment to both graduate and undergraduate teaching are required. Successful applicants will be expected to interact with the applied science faculty at USU, as well as colleagues in mathematics and statistics. The ability to provide broad scholarly leadership is essential for senior-level applicants.

Utah State University, located in the Wasatch Range of the Rocky Mountains, offers competitive salaries and excellent medical, retirement and professional benefits.

Applications, including resume and three letters of reference, should be submitted to: Michael P. Windham, Search Committee, Department of Mathematics and Statistics, Utah State University, Logan, UT 84322-3900. Preference will be given to applications completed by January 31, 1990, but all will be considered until available positions are filled.

Utah State University is an equal opportunity/affirmative action employer.

UNIVERSITY OF CALIFORNIA SANTA CRUZ

The Mathematics Department at the University of California, Santa Cruz is recruiting for a position in nonlinear analysis/differential geometry, at either the Assistant (tenure-track) Associate or Full Professor (tenured) level. Salary will be in the range of \$33,900-\$36,000 (Asst. Prof.), \$40,400-\$45,200 (Assoc. Prof.), \$48,500-\$69,400 (Full Prof.), effective July 1, 1990. The teaching load is 4 one-quarter courses per year. Minimal qualification is a Ph.D. or equivalent in math. Candidates for the tenure level are expected to have an exceptionally strong research record as well as a solid teaching record. Candidates for the untenured level should demonstrate strong potential for such. Applicants should send vita, including teaching and research record (indicating at which level you wish to be considered), and four letters of recommendation to: Recruitment Committee, Mathematics Department, University of California, Santa Cruz, CA 95064. Closing Date: February 1, 1990. Please refer to #36-856 in our reply. Applications from women and minorities are particularly welcomed. UCSC is EEO/AA/IRCA EMPLOYER.

POSITIONS AVAILABLE

SOUTHWEST MISSOURI STATE UNIVERSITY Department of Mathematics

Several tenure track positions and possibly some visiting positions in Mathematics and Statistics are available beginning August 20, 1990. Rank and Salary will be commensurate with qualifications. Applicants must have a PhD in Mathematics or Statistics, evidence of excellence in teaching, and a commitment to continued research. For all positions preference given to applicants with research interests compatible with those of the current faculty and for at least one position preference given to applicants with research interest in algebra. Duties include teaching, research, and service. Applications will be reviewed as received and will be accepted until the positions are filled or until April 1, 1990—the final deadline for all application materials. Send application (resume, three letters of reference, graduate transcripts, and a letter of interest) to: Dr. M. Michael Awad, Head, Department of Mathematics, Southwest Missouri State University, Springfield, MO 65804-0094. AA/EOE.

PURDUE UNIVERSITY CALUMET MATHEMATICAL SCIENCES HAMMOND, IN 46323

Assistant Professor, tenure-track position, August 1990. **Requirements:** Ph.D. in mathematics or statistics; demonstrated teaching ability and research potential; U.S. Citizenship or Permanent Residency. **Responsibilities:** Undergraduate and graduate teaching and research.

Submit a letter of application, a curriculum vitae, graduate school transcripts. Also arrange for three letters of recommendation, at least one of which addresses your research potential and at least one of which addresses your teaching ability. All materials should be sent to:

C. M. Murphy, Head
Dept. of Mathematical Sciences
Purdue University Calumet
Hammond, IN 46323

Applications received by February 15, 1990, will be considered first. Minorities and women are encouraged to apply. Purdue University Calumet is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF CALIFORNIA AT RIVERSIDE Faculty Position in Mathematics

Applications and nominations are invited for a tenured or tenure track position in Algebraic Geometry or Commutative Algebra beginning July 1, 1990 or later. The position is open as to rank; candidates at all levels and in all areas of algebraic geometry and commutative algebra will be considered. Demonstrated excellence in research and teaching is required. The eligibility pool for this position will consist of those candidates for whom we receive a vita, a list of publications and three letters of recommendation by January 22, 1990. Established criteria of the University of California determine salary and rank. Candidates should send a curriculum vita, a list of publications and the names of at least three references to Professor Richard Block, Chair Algebraic Geometry/Commutative Algebra Hiring Committee Department of Mathematics and Computer Science University of California Riverside, California 92521 University of California is an Affirmative Action/Equal Opportunity Employer.

JOHNS HOPKINS UNIVERSITY

The Mathematical Sciences Department invites applications for the 1990-91

ELIEZER NADDOR POSTDOCTORAL FELLOWSHIP.

The Fellow is to be an outstanding graduating doctoral student in mathematics, statistics, or operations research, who plans an academic research center. The fellowship provides a \$29,000 stipend plus fringe benefits, to fully support 12 months of post-doctoral study at the department in an area of interest to some department faculty member, free from teaching and administrative duties. Selection is made without discrimination on the basis of race, color, religion, sex, or national origin. Applicants should provide a current vita, a letter describing career aspirations and a research plan for the fellowship year, and transcripts, and should arrange for three letters of recommendation to be sent, by February 28, 1990, to:

Professor John C. Wierman, Chairman
Mathematical Sciences Department
220 Maryland Hall
The Johns Hopkins University
Baltimore, Maryland 21218

EOE/AA

UNIVERSITY OF MARYLAND BALTIMORE COUNTY

The Department of Mathematics and Statistics at the University of Maryland Baltimore County has been authorized to recruit for three positions for the fall of 1990. At least one of these will be at the senior level and one of these will be in Statistics. The department has strengths in control theory and optimization, ordinary and partial differential equations and mathematical modeling, numerical analysis and scientific computing, as well as probability theory and statistics, and seeks strong applicants in these or any other related field. Interested candidates should send a curriculum vita, list of publications, and three letters of reference to James M. Greenberg, Chairman, Department of Mathematics and Statistics, University of Maryland Baltimore, County, Baltimore, MD 21228. Applicants will be considered until a suitable candidate is found. THE UNIVERSITY IS AN EQUAL OPPORTUNITY EMPLOYER AND SPECIFICALLY INVITES APPLICATIONS FROM WOMEN, MINORITIES, AND DISABLED PERSONS.

WESTERN CAROLINA UNIVERSITY

Nominations and applications are invited for the position of Head, Department of Mathematics and Computer Science. The department has eighteen full time faculty members and offers programs leading to the B.S., B.S. Ed., M.S., and M.A. Ed. degrees with majors in mathematics, and the B.S. degree with a major in computer science. Western Carolina University has an enrollment of 6200 and is a member of the University of North Carolina system. The successful candidate should have a terminal degree, a sustained record of quality teaching, research, and service, and an interest in both undergraduate and graduate program development, as well as administrative experience and/or potential.

Applicants should send a resume, graduate transcripts, and three letters of reference to: Dr. James H. Horton, Chair, Mathematics and Computer Science Search Committee, School of Arts and Sciences, Western Carolina University, Cullowhee, NC 28723. WCU is an Equal Opportunity/Affirmative Action Employer. Closing date for receipt of applications is March 1, 1990.

POSITIONS AVAILABLE

UNIVERSITY OF CALIFORNIA SANTA BARBARA DEPARTMENT OF MATHEMATICS

Applications are invited for the KY FAN ASSISTANT PROFESSORSHIP. The Ky Fan assistant professorship is a special two-year non-renewable position which carries a research stipend. Appointment is effective July 1, 1990. Candidates must possess a Ph.D. by September 1990. Selection will be based primarily on demonstrated research achievement. Teaching experience is desirable. Teaching load will consist of four quarter courses per year. To apply send vita and publication list, and arrange to have 3 letters of recommendation sent to: Ky Fan Faculty Search Committee, Department of Mathematics, University of California, Santa Barbara, CA 93106. All applications received by January 10, 1990 will be given thorough consideration. UCSB is an Equal Opportunity/Affirmative Action employer. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Reform and Control Act of 1986).

UNIVERSITY OF SOUTH CAROLINA COASTAL CAROLINA COLLEGE

MATHEMATICS. USC Coastal Carolina College is seeking a person committed to excellence in classroom instruction, sensitivity to student needs and curriculum development. Tenure track position at rank of Assistant or Associate Professor available Fall, 1990. Qualifications: Ph.D. in Mathematics; teaching experience. Statistical background preferred. Salary negotiable and competitive. USC Coastal Carolina College, the fastest growing 4-year regional campus of the University of South Carolina, is located 9 miles west of Myrtle Beach. All applicants should submit a letter of application, curriculum vitae, and names and addresses of references to: Dr. Janis W. Chesson, Assistant Chancellor for Human Resources and Affirmative Action, USC Coastal Carolina College, P.O. Box 1954, Conway, SC 29526. Screening of applications will begin February 1, 1990, and will continue until position is filled. Applications from women and minorities are encouraged. USC Coastal Carolina College is an EOE/AA Employer.

UNIVERSITY OF CALIFORNIA AT RIVERSIDE Faculty Position in Mathematics

Applications and nominations are invited for a tenured or tenure track position in Analysis beginning July 1, 1990 or later. The position is open as to rank; candidates at all levels and in all areas of analysis will be considered. Demonstrated excellence in research and teaching is required. The eligibility pool for this position will consist of those candidates for whom we receive a vita, a list of publications and three letters of recommendation by January 22, 1990. Established criteria of the University of California determine salary and rank. Candidates should send a curriculum vitae, a list of publications and the names of at least three references to:

Professor M. M. Rao, Chair
Analysis Hiring Committee
Department of Mathematics and
Computer Science
University of California
Riverside, California 92521

University of California is an Affirmative Action/Equal Opportunity Employer.

FLORIDA INTERNATIONAL UNIVERSITY *The State University of Florida at Miami*

The Department of Mathematics announces two junior tenure track positions beginning August 1990. Candidates must have a Ph.D. in Mathematics and a commitment to research and quality teaching. Preferred areas of specialization include harmonic analysis, logic, representation theory, complex variables, and differential geometry. Qualified candidates in other areas will be considered.

Teaching load consists of 15 semester hours per academic year. Send resume and 3 letters of recommendation to Recruitment Committee, Department of Mathematics, Florida International University, Miami, FL 33199.

Florida International University is the State University of Florida at Miami. The university is an equal opportunity/affirmative action employer.

ILLINOIS WESLEYAN UNIVERSITY DEPARTMENT OF MATHEMATICS BLOOMINGTON, IL 61702

Applications are invited for a tenure track position at the rank of Assistant Professor starting the fall semester 1990. Candidates must possess a Ph.D. in mathematics, a dedication to excellent teaching in an independent, liberal arts university, and active research interests. Preference will be given to individuals with active interests in applied mathematics. The initial closing date for applications is January 10, 1990 (prior to the AMS/MAA Louisville meeting). Thereafter until the position is filled, the closing dates are February 10, March 10, and April 10. Women and minorities are strongly encouraged to apply. Candidates should submit a curriculum vitae and three letters of recommendation to Melvyn W. Jeter, Head, Department of Mathematics, Illinois Wesleyan University, Bloomington, IL 61702. Equal Opportunity Employer.

STANFORD UNIVERSITY Department of Mathematics and Statistics

We invite applications for a tenure-track position in probability at the Assistant Professor level beginning Autumn Quarter 1990 to 1991. The position is a joint appointment in the Department of Mathematics and Statistics. Excellent research potential in probability and stochastic processes, strong interest in applications, and commitment to quality teaching are required. Outstanding candidates at higher ranks will also be considered. Please submit applications, curriculum vitae and letters from three professional references to: Yitzhak Katznelson, Chair of Search Committee, Department of Mathematics, Stanford University, Stanford, CA 94305-2125, U.S.A.

Stanford University is an Equal Opportunity, Affirmative Action Employer, and encourages applications from women and minorities.

POSITIONS AVAILABLE

BRADLEY UNIVERSITY Department of Mathematics

Applications are invited for an entry level tenure-track position at the rank of Assistant Professor beginning August, 1990. Candidates should have a strong commitment to undergraduate teaching. The Ph.D. is required, and continuing professional growth (publication) is necessary for tenure and advancement. Applicants from all areas are invited. Special consideration will be given to those in the fields of statistics, mathematical modeling, discrete mathematics, and geometry. Salary is competitive. The closing date is January 12, 1990, or until the position is filled. Other positions may become available at a later date. Send letter of application, vita, and three or more letters of recommendation to: Dr. T. V. Sastry, Search Committee, Department of Mathematics, Bradley University, Peoria, IL 61625. Bradley University is an AA/EO employer. Women and minorities are encouraged to apply.

KANSAS STATE UNIVERSITY Department of Mathematics

Subject to budgetary approval, applications are invited for several tenure track and visiting positions commencing August 18, 1990; rank and salary commensurate with qualifications. All fields will be considered, but, for the tenure track positions, preference will be given to candidates in Low Dimensional Topology, Geometric Topology, and Algebraic Topology. Applicants must have strong research credentials and a commitment to excellence in teaching. A Ph.D. in mathematics or a Ph.D. dissertation accepted with only formalities to be completed is required. Letter of application, current vita, description of research and three letters of recommendation should be sent to:

Louis Pigno
Department of Mathematics
Cardwell Hall 137
Kansas State University
Manhattan, KS 66506

Deadline: February 1, 1990. AA/EOE

UNIVERSITY OF TORONTO Department of Mathematics Scarborough Campus

Applications are invited for a limited term Assistant Professorship, from July 1, 1990 to June 30, 1991. There is a possibility that a two year appointment may become available. Duties consist of teaching and research, and candidates must clearly demonstrate strength in both. Applications, including a complete curriculum vitae, should be sent to Professor J. M. Perz, Chair, Physical Sciences Division, Scarborough Campus, University of Toronto, 1265 Military Trail, Scarborough, Ontario M1C 1A4. Applicants should arrange for at least three letters of reference to be sent directly to the Chair; at least one of these should refer to teaching. The deadline for applications is February 15, 1990. In accordance with Canadian Immigration requirements priority will be given to Canadian citizens and permanent residents of Canada. The University of Toronto encourages both women and men to apply for positions.

NORTHWESTERN UNIVERSITY MATHEMATICS DEPARTMENT 2033 Sheridan Road Evanston, Illinois 60208-2730

The Mathematics Department will sponsor an emphasis year in Dynamical Systems during the year 1990-91. The department expects to fill one or two 2-year Assistant Professorships starting September 1990 with priority given to mathematicians with research interests in Dynamical Systems. There is the further possibility for more senior mathematicians of visiting positions for part or all of the academic year.

Applications should be sent to Prof. Clark Robinson at the department address and include a curriculum vitae and three letters of recommendation. In order to ensure full consideration, an application must be received by February 28.

Northwestern University is an Affirmative Action/Equal Opportunity employer. Hiring is contingent upon eligibility to work in the United States.

KENNESAW STATE COLLEGE Mathematics Department P.O. Box 444 Marietta, GA 30061

At least one tenure track position in Mathematics at the level of Assistant Professor beginning in September, 1990. A Ph.D. is required with a strong commitment to undergraduate education as well as an interest in scholarly activities. Preference will be given to degrees in Combinatorial Group Theory, Combinatorics, or Statistics. Salary and rank are competitive and commensurate with credentials and experience. The College is located in Northwest Metro Atlanta, and enrolls over 9000 day and evening students in undergraduate and graduate programs. The department of Mathematics has 18 full-time faculty and shares 6 others with the Department of Computer Science. Send resume and a list of three reference to Dr. Nancy E. Zumoff, Chair, Search Committee. Application deadline is March 1, 1990, or until filled (EOE/AA)

MANHATTAN COLLEGE DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

Two tenure track positions at the rank of Assistant Professor, commencing fall semester, 1990. Duties of one position include teaching undergraduate courses in mathematics, especially probability and statistics, and introductory computer science. Duties of the other position include teaching a combination of upper and lower level undergraduate courses in mathematics and computer science. Candidates should possess a doctorate and strong research ability with a firm commitment to teaching.

Send resumes by February 1, 1990, to Prof. Francis B. Taylor, Chairman of the Search Committee, Department of Mathematics and Computer Science.

MANHATTAN COLLEGE
Riverdale, NY 10471

AA/EO Employer M/F

Women and Minorities are encouraged to apply

POSITIONS AVAILABLE

LOUISIANA TECH UNIVERSITY

The Mathematics and Statistics Department anticipates having three tenure track positions open at the Assistant Professor level for academic year 1990-91. Candidates must have a Doctorate in Mathematics or Statistics, a commitment to teaching and a research record or potential. The specialty areas considered are statistics, modeling theory, and differential equations. The salary is competitive. Send vita, three letters of reference, and transcripts by February 15, 1990 to: (Applications will be considered until the positions are filled).

John E. Maxfield, Interim Head
Department of Mathematics and
Statistics

Louisiana Tech University
P.O. Box 3189 T.S.
Ruston, LA 71272

Louisiana Tech University is an Affirmative
Action/Equal Opportunity Employer.

UNIVERSITY OF COLORADO AT COLORADO SPRINGS DEPARTMENT OF MATHEMATICS COLORADO SPRINGS, CO 80933-7150

Applications are invited for 1 or 2 possible tenure track Assistant Professor positions for Fall 1990. Prefer areas consistent w/present research interests: algebra, diff. eq., computer vision, harmonic analysis, probability and math physics. Applicants should have significant research accomplishments or exceptional research promise and evidence of good teaching. Ph.D. is required. The average weekly teaching load is 7 1/2 hours. Generous support for faculty development such as travel, teaching off-loads and summer research. Send resume and 3 letters of reference to James E. Daly, Chairman. Screening will begin on Feb. 1, 1990 and continue until all positions are filled. AA/EEO.

SYRACUSE UNIVERSITY Department of Mathematics

We anticipate positions available at the Assistant and Associate Professor level beginning Fall 1990. Candidates should have outstanding research ability and evidence of excellence in teaching. Applications are invited in any area of mathematics and in mathematics education and statistics. Send a letter of application and vita with a list of publications and three references to: Daniel Waterman, Chair, Syracuse University, Department of Mathematics, Box 1, Syracuse, NY 13244-1150.

BOWLING GREEN STATE UNIVERSITY EUGENE LUKACS VISITING PROFESSORSHIP

The Department of Mathematics & Statistics at Bowling Green State University is pleased to announce the establishment of a Eugene Lukacs Visiting Professorship in Statistics. This Distinguished Visitor position is named in memory of Eugene Lukacs (1906-1987), whose many distinctions include being named the first "University Professor" at Bowling Green State University in recognition of his outstanding contributions to Analytic Probability Theory. In combination with a Post-Doctoral and Graduate Fellowship in Statistics, this Professorship is part of an Academic Challenge Award from the Ohio Board of Regents to the Statistics Program in the Dept. of Mathematics & Statistics. All three positions are non-teaching. Contact: Hassoon S. Al-Amiri, Chair, Dept. of Mathematics & Statistics, BGSU, Bowling Green, OH 43403, USA. EO/AA Employer.

SEATTLE UNIVERSITY

Applications are invited for a tenure-track position at the Assistant Professor rank beginning September, 1990. Candidates must have a Ph.D. in mathematics, proven teaching ability, commitment to working with students in service courses, and involvement in research activity. Preference may be given to a person with a background in some area of applied mathematics. To apply, send vita, transcripts, and three letters of recommendation to Dr. Janet E. Mills, Chair, Mathematics Department, Seattle University, Seattle, WA 98122. Closing date is Feb. 9, 1990. Seattle University is committed to improving the diversity of its faculty and encourages qualified women and underrepresented minorities to apply. Affirmative Action/Equal Opportunity Employer.

CANISIUS COLLEGE DEPARTMENT OF MATHEMATICS

Applications are invited for a tenure track position in mathematics to begin in late August 1990. Applicants must have the Ph.D. in mathematics and a strong commitment to quality teaching. Salary and fringe benefits are competitive commensurate with credentials and experience. Applicants should send resume, transcripts and three letters of recommendation to Dr. Richard Escobales, Chairman, Department of Mathematics, Canisius College, Buffalo, NY 14208. AA/EOE.

BOWLING GREEN STATE UNIVERSITY

The Department of Mathematics and Statistics at Bowling Green State University announces an anticipated tenure track/tenure position in Algebra at the rank of Associate Professor. Ph.D. in Mathematics required. Experience in advising Ph.D. students in algebra preferred, overlapping interest with interests of the active algebraist group in the department. *Duties:* Teach two courses per semester; involvement in research, seminars and directing theses at the Ph.D. level. Salary range is \$40,000-\$60,000 for the academic year. *Starting Date:* 8/15/90. Deadline: 3/20/90 or until qualified candidate is found. Send credentials (vita, 3 letters of reference & an official transcript) to: Dr. H. S. Al-Amiri, Chair, Dept. of Mathematics & Statistics, BGSU, Bowling Green, OH 43403. BGSU an EO/AA Employer.

UNIVERSITY OF SOUTH FLORIDA Department of Mathematics

At least one tenure-track position is available beginning August 1990. Applicants must possess a Ph.D. degree. Applicants specializing in analysis (numerical analysis, approximation theory, special functions); differential equations; probability/mathematical statistics; theory of computation (algebra, combinatorics, logic) are preferred but other outstanding candidates will be considered. Rank and salary will depend on credentials. To apply, send curriculum vitae and have three letters of recommendation sent to Kenneth L. Potholm, Chairman, University of South Florida, Department of Mathematics, Tampa, FL 33620-5700. Application deadline: February 12, 1990. The University of South Florida is an equal opportunity employer.

DUTCHESS COMMUNITY COLLEGE

INSTRUCTOR/ASSISTANT PROFESSOR
Tenure-track available September 1, 1990. The position requires a Master's degree in mathematics or a related field with appropriate coursework in mathematics. The position will be expected to teach a wide variety of courses from remedial mathematics to differential equations. Send letter of application and resume to: Mr. Paul Higgins, Personnel Administrator, Dutchess Community College, 53 Pendell Road, Poughkeepsie, NY 12601-1595. Qualified women and minorities encouraged to apply. AA/EOE.

POSITIONS AVAILABLE

UNIVERSITY OF ILLINOIS AT CHICAGO Department of Mathematics, Statistics, and Computer Science, Box 4348, Chicago, IL 60680.

Applications are invited for positions effective September 1, 1990, in pure and applied mathematics, probability and statistics, theoretical computer science, and mathematics education. Outstanding research record required; junior candidates with post-doctoral experience preferred.

Applications are also invited for visiting positions of one or more quarters. Send vita and direct 3 letters of reference to John Baldwin, Chairman, Search Committee (address above). To ensure full consideration materials must be received by January 15, 1990. AA/EOE.

UNIVERSITY OF MICHIGAN

UNIV OF MICHIGAN, DEARBORN, DEPT OF MATH & STAT, DEARBORN, MICHIGAN 48128-1491. Department Chair Ronald P. Morash. The U of M-Dbn plans to fill a tenure track position starting in Sept. 1990. It is at the Asst. or Assoc. Prof. level and requires a Ph.D. in Mathematics or Statistics. A research interest in an applied area of mathematics or in statistics is preferred. Teaching capability in an applied area of mathematics or in statistics is a requirement for this position. The teaching load is 9 credit hours per term. To apply, send resume and have 3 letters of recommendation sent to Ronald P. Morash, Chairman, Dept. of Math. and Stat. The Univ of Mich-Dbn is an Equal Opportunity Employer and specifically invites and encourages applications from women and minorities.

UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE TEACH IN ASIA OR EUROPE

The University of Maryland University College seeks excellent teachers for openings on U.S. military bases overseas. Appointments begin August, 1990. Requirements include M.A. or Ph.D., recent college teaching experience, and U.S. citizenship. Competence to teach in another discipline desirable. Benefits include transportation and military base privileges (PX, commissary, etc.). Frequent travel and the cost of schooling make these positions difficult for those with children. Send resume to Dr. Ralph E. Millis, Assistant to the President, Overseas Programs, The University of Maryland University College, College Park, MD 20742-1642. AA/EEO.

TEXAS A & I UNIVERSITY DEPARTMENT OF MATHEMATICS

Applications are invited for tenure-track positions of Assistant, Associate, or Full Professor beginning August, 1990. Candidates must have a Ph.D. in mathematics, tangible evidence of scholarly publications, and a strong commitment to superior teaching. Experience in Ph.D. program and directing Ph.D. dissertations in applied mathematics, numerical analysis or differential equations is preferred. Send resume and three letters of recommendation to:

Dr. Margaret F. Land, Chair
Department of Mathematics
Texas A & I University
Kingsville, TX 78363-8201

Deadline is February 1, 1990, or until positions are filled. A Part of the Texas A & M University System. AA/EOE.

RICE UNIVERSITY Department of Mathematics

Applications are invited for a tenure track assistant professorship. There is a possibility of an upgrade to associate or full professorship for an exceptional senior candidate. Candidates must have an extremely strong research background and good teaching skills. Preference will be given to applicants in low-dimensional topology, although outstanding candidates in analysis, geometry, and topology will also be considered.

Please send a curriculum vitae and at least 3 letters of recommendation to: Appointments Committee, Department of Mathematics, Rice University, P.O. Box 1892, Houston, Texas 77251.

Rice University is an Equal Opportunity/Affirmative Action Employer.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY DEPARTMENT OF MATHEMATICS

We are seeking applications for one senior visiting appointment (Associate or Full Professor) for the academic year 1990-1991. Duties are expected to include teaching a topics course and interacting with faculty and graduate students. The review of applications will begin on November 15, 1989 and continue until the position is filled. To apply submit a curriculum vita to: Chairman, Senior Visitor Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Women and minorities are encouraged to apply. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

SUNY, COLLEGE AT NEW PALTZ

SUNY, COLLEGE AT NEW PALTZ Tenure track position available for PhD or EDD in Mathematics Education having MA in Mathematics, or PhD in Mathematics with research interests in Mathematics Education. Begin 9/90. Evidence of excellence in teaching & scholarly potential. College in Hudson Valley/Catskill region of New York, with easy access to NYC offers BS and MS in Mathematics, Computer Science, and Mathematics Education. Send letter, professional resume and names, addresses & telephone numbers of three references to D. Clark, Chair, Department of Mathematics and Computer Science, Box 10, SUNY, College at New Paltz, NY 12561. Review of resumes begins 1/1/90, pending budgetary approval. AA/EOE. Women and minorities urged to apply.

UNIVERSITY OF SOUTH FLORIDA Department of Mathematics

At least one tenure-track position is available beginning August 1990. Applicants must possess a Ph.D. degree. Applicants specializing in analysis (numerical analysis, approximation theory, special functions); differential equations; probability/mathematical statistics; theory of computation (algebra, combinatorics logic) are preferred but other outstanding candidates will be considered. Rank and salary will depend on credentials. To apply, send curriculum vitae and have three letters of recommendation sent to Kenneth L. Pothoven, Chairman, University of South Florida, Department of Mathematics, Tampa, Florida 33620-5700. Application deadline: February 12, 1990. The University of South Florida is an equal opportunity employer.

UNIVERSITY OF GEORGIA Department of Mathematics Athens, GA 30602

The department may have some tenure track positions available for the 1990-91 academic year at the assistant and associate professor levels. The rank and salary will be commensurate with the applicant's abilities and experience. The principal requirement is excellence in teaching and research. Some preference will be given to areas in which the department is already well represented. Send curriculum vitae and four letters of recommendation to Richard A. Bouldin, Head (address above) by January 15, 1990. UGA is an Equal Opportunity/Affirmative Action Employer.

POSITIONS AVAILABLE

COMMUNITY COLLEGE OF PHILADELPHIA

MATHEMATICS—The Mathematics Dept. invites applications for a possible 1990 tenure track position. Candidates must have at least a Master's Degree in Mathematics, a commitment to quality teaching, both remedial and college level students, and a serious interest in curriculum development. The department is actively engaged in developing new mathematics courses. It has recently received grants from NSF and CASET. Outstanding benefits. Send curriculum vitae and 3 letters of recommendation to: Dept. of Mathematics Chair, COMMUNITY COLLEGE OF PHILADELPHIA, 1700 Spring Garden St., Phila., PA 19130. Women and minorities are encouraged to apply. AA/EOE.

MICHIGAN TECHNOLOGICAL UNIVERSITY Department of Mathematical Sciences

Subject to final administrative approval, we expect to fill the following positions. Starting date is Sept. 1990.

1. One tenure-track Assistant Professorship. Strong research and teaching background required. Teaching load: five quarter courses per year.

2. At least two Visiting Assistant Professorships. These are one year positions with a teaching load of six quarter courses per year.

3. One instructorship. An M.S. and strong teaching background is required. Teaching load: nine quarter courses per year.

To apply, submit vitae and three letters of recommendation to Recruitment Committee, Dept. of Math. Sciences, MTU, Houghton, MI 49931. MTU is an equal opportunity educational institution/equal opportunity employer.

FAIRFIELD UNIVERSITY Tenure-track Position in Mathematics

An entry level Assistant Professor is sought to start in September 1990 who must have a Ph.D. in Mathematics and evidence of teaching ability. Normal teaching load is 3 courses per semester plus research. Salary is competitive and full consideration is given to dossiers completed by February 1, 1990. Please send a resume and three letters of reference to Joseph B. Dennin, Chair, Dept. of Math and Computer Science, Fairfield University, Fairfield, CT 06430-7524. Fairfield is a Jesuit University located 60 minutes from New York City. It is an Equal Opportunity/Affirmative Action Employer.

MICHIGAN TECHNOLOGICAL UNIVERSITY

The Department of Mathematical Sciences is seeking a director for the Fluids Research Oriented Group (F.R.O.G.). F.R.O.G. is an interdisciplinary group, involving Departments of Mathematical Sciences, Mechanical Engineering, and Chemical Engineering, engaged in an active program of research in Fluid Mechanics. This position will carry an appointment as Associate Professor or Professor. Candidates should have an active research record in Fluid Mechanics or Computational Mathematics. A good funding record and experience with Ph.D. students is required. The position starts in September 1990. Send a curriculum vitae and three letters of recommendation to Recruitment Committee, Dept. of Math. Sciences, MTU, Houghton, MI 49931. MTU is an equal opportunity educational institution/equal opportunity employer.

MICHIGAN TECHNOLOGICAL UNIVERSITY Department of Mathematical Sciences

We invite applications and nominations for the position of Department Head. The department offers B.S. and M.S. degrees and is developing a Ph.D. program. We have a strong commitment to research, especially in Applied Mathematics, and to excellence in undergraduate education. We are seeking a distinguished senior mathematician to further develop and enhance our programs. To apply, send a curriculum vitae and at least three letters of recommendation to Head Search Committee, Dept. of Math. Sciences, MTU, Houghton, MI 49931. MTU is an equal opportunity educational institution/equal opportunity employer.

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL Dept. of Mathematics Chapel Hill, N.C. 27599-3250

Applications are invited for one appointment at the tenured Associate or Full Professor level, effective Fall 1990. A Ph.D. and demonstrated excellence in research and teaching are required. Applications will be accepted until the position is filled; however applications received by February 15, 1990, are assured of full consideration. Send 4 letters of recommendation, vitae, and abstract of current research program to Search Committee, c/o Deborah Reives, Mathematics Dept., CB #3250 Phillips Hall, UNC at Chapel Hill, Chapel Hill, NC 27599-3250. EO/AA Employer. Women and minorities are encouraged to identify themselves voluntarily.

UNIVERSITY OF KANSAS Department of Mathematics

Applications are invited for tenure-track and temporary positions at all levels, commencing August 16, 1990 or as negotiated. Field of interest unrestricted but preference will be given to numerical analysis then to probability/statistics then to areas meshing well with the department's needs. Require Ph.D. or Ph.D. dissertation accepted with only formalities to be completed.

Application, detailed resume with description of research, and three recommendation letters should be sent to C. J. Himmelberg, Chairman, Department of Mathematics, University of Kansas, Lawrence, KS 66045-2142.

Deadlines: December 1, 1989 for first consideration, then monthly until August 1990.

The University of Kansas is an AA/EOE.

LOYOLA UNIVERSITY OF CHICAGO

The Department of Mathematical Sciences anticipates at least one tenure track position and some visiting positions beginning August, 1990. Requirements are the Ph.D. and an active research program in any area and a commitment to quality teaching. The department offers courses in mathematics, computer science, and statistics at the undergraduate and masters level. Interviews will begin in January and continue until all positions are filled. Send detailed C.V. and three letters of recommendation to Professor J. Lucas, Department of Mathematical Sciences, Loyola University, Chicago, IL 60629. Loyola University of Chicago is an Equal Opportunity/Affirmative Action Employer.

SUNY COLLEGE AT BROCKPORT

Tenure-track assistant professorship in Mathematics available September 1990. Applicants should have a Ph.D. in Mathematics with expertise in Discrete Math, Probability, Statistics, or Operations Research, and strong commitment to the teaching of Mathematics to a culturally diverse student body at the Undergraduate and Masters' level. Demonstrated ability to conduct and publish scholarly research. For details, contact N. Bloch, Chairperson, Department of Mathematics (phone: 716-395-2194). To apply, send a letter of application and resume and three letters of reference sent by January 1990, to the Office of Faculty/Staff Relations, SUNY College at Brockport, Brockport, NY 14420. AA/EOE

POSITIONS AVAILABLE

CALIFORNIA STATE POLYTECHNIC UNIVERSITY

Two tenure track teaching positions: one in Mathematics Education, salary dependent upon qualifications, Doctorate in Mathematics Education or Mathematics; one in Applied Mathematics at the assistant professor level, salary dependent upon qualifications, Doctorate in Applied Mathematics or Mathematics. Evidence of potential for excellent teaching and scholarly research required. Application, resume, copy of transcripts and three references to be postmarked by 2/16/90. For additional information or to apply, contact: Search Committee, Mathematics Department, California State Polytechnic University, 3801 W. Temple Ave., Pomona, CA 91768-4033. (714)869-3467. EOE/AA

COLLEGE OF STATEN ISLAND (CUNY) Department of Mathematics

A tenure-track position in mathematics is available for Fall 1990. Requirements: Ph.D., strong commitment to teaching; published research beyond the Ph.D. All mathematics research areas will be considered with special preference given to probability and statistics. Rank and salary commensurate with qualifications. The College of Staten Island is a senior college in CUNY. Send resume and three letters of reference to: Dr. Jane Coffee, Mathematics Department, College of Staten Island, 130 Stuyvesant Place, Staten Island, N.Y. 10301 by January 31, 1990. AA/EOE Employer.

SOUTHERN CONNECTICUT STATE UNIVERSITY MATHEMATICS DEPARTMENT 501 CRESCENT ST. NEW HAVEN, CT 06515

Tenure track position at asst/assoc rank beginning 8/27/90 to teach ungrad/grad math and math ed., supervise secondary student teachers (12 hrs). Qualifications: doctorate in math, or math ed., evidence of quality teaching, experience in teacher ed. programs, potential for scholarly growth.

Send application, vita, transcripts, references to Dr. Helen Bass, chair. Full consideration given to applications received by 1/31/90. (AA/EOE)

ALBION COLLEGE Albion, Michigan

Tenure-track position at the assistant professor level in mathematics department. Starts August, 1990. Salary competitive; excellent fringe benefits. Ph.D. in mathematics or statistics with strong emphasis in applied statistics. Evidence of excellence in teaching required. Albion College encourages applications from minority candidates and women. Direct inquiries to R. C. Fryxell, Chairman, Mathematics Department, Albion College, Albion, MI 49224, (517)629-0287. (BITnet address: RFRYXELL@ALBION) Albion College is an equal opportunity employer.

SOUTHERN CONNECTICUT STATE UNIVERSITY MATHEMATICS DEPARTMENT 501 CRESCENT ST. NEW HAVEN, CT 06515

Tenure track position at asst/assoc rank beginning 8/27/90 to teach ungrad/grad math, including stat. and appl. math. (12 hrs). Qualifications: doctorate in math, evidence of quality teaching, expertise in stat. or appl. math, potential for scholarly growth.

Send application, vita, transcripts, references to Dr. Helen Bass, Chair. Full consideration given to applications received by 1/31/90. (AA/EOE)

WHITTIER COLLEGE

The Department of Mathematics and Computer Science invites applications for a tenure-track position, at the level of Asst. Prof. beginning Fall 1990. The five members of the department teach a wide range of undergraduate courses in Mathematics and Computer Science. Ph.D. in Mathematics is expected, but no particular field is required. Participation in the teaching of college-wide courses such as College Writing and interdepartmental courses such as Quantitative Management courses is most welcome. Candidates should send a vita, a statement of teaching philosophy, and three letters of recommendation to Chairman, Department of Mathematics and Computer Science, Whittier College, Whittier, CA 90608. The processing of applications will begin on Feb. 15, 1990. However, applications will be accepted until the position is filled. EOE/AA

UNIVERSITY OF CALIFORNIA AT BERKELEY DEPARTMENT OF STATISTICS

Pending final budgetary approval, we invite applications for a faculty position at any **tenured or tenure-track rank**, to begin July 1, 1990. We will consider strong candidates in any area of theoretical and applied statistics, probability and applied probability theory.

Interdisciplinary interests are encouraged and joint appointments are a possibility. The department is particularly interested in hearing from suitably qualified women or members of minorities currently underrepresented in faculty positions. Send inquiries and applications including a resume and three references by January 30, 1990 to:

David R. Brillinger
Personnel Committee
Department of Statistics
University of California
Berkeley, CA 94720

(Applications received for our earlier November 30, 1989 deadline will automatically be considered for this deadline also.) The University of California is an Equal Opportunity Affirmative Action Employer.

Please note:

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in North America

1-800-321-4AMS

(321-4267)

MATHEMATICAL REVIEWS

ASSOCIATE EDITOR

Applications and recommendations are invited for a two-year appointment as an Associate Editor of *Mathematical Reviews* (MR), to commence no later than the summer of 1990. Applications will be welcomed from persons taking leave from other positions, and in particular from tenured faculty members who can take leave to come to MR for two years.

The MR office of the American Mathematical Society is located in Ann Arbor, Michigan, not far from the campus of the University of Michigan, and the editors (although employees of the AMS) enjoy many privileges at the university. At present MR employs fourteen mathematical editors, about ten consultants, and over sixty nonmathematicians. It produces *Mathematical Reviews*, *Current Mathematical Publications*, various indexes, the online service MathSci, and MathSci Disc. The responsibilities of an Associate Editor fall primarily in the day-to-day operations of selecting articles and books suitable for review, classifying these items, assigning them to reviewers, editing the reviews when they are returned, and correcting galley proof. At this time an individual with considerable breadth in applied mathematics is sought (such as in differential equations, optimization, operations research, systems theory, control theory, information theory, etc.). The ability to write good English is essential, and the ability to read mathematics in major foreign languages is important. (The ability to read mathematical articles in Russian or Chinese is especially desirable.)

Persons interested in combining a sabbatical or other leave with a part-time appointment as an Associate Editor should write (or telephone) for further details. The twelve-month salary is negotiable, and will be commensurate with the experience the applicant brings to the position. Salary and fringe benefits are similar to those in universities. Of special importance is a policy providing termination pay of three months full pay for an editor serving full time for two years.

Applications (including curriculum vitae, bibliography, and names and addresses of at least three references) and recommendations should be sent to Dr. R. G. Bartle, Executive Editor, *Mathematical Reviews*, P. O. Box 8604, Ann Arbor, MI 48107-8604. (Telephone: 313-996-5255; FAX: 313-996-2916; INTERNET: RGB@MATH.AMS.COM.) Persons who may be interested in applying for this position are urged to inquire without delay.

The American Mathematical Society is an equal opportunity employer.

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American Mathematical Society

OPEN
POSITION

MATHEMATICAL REVIEWS EXECUTIVE EDITOR

Applications and nominations are invited for the position of Executive Editor of Mathematical Reviews (MR).

The Executive Editor is the chief executive officer at MR and is responsible for all phases of its operations. These duties include:

- direction of the editorial and consulting staff and the administration of the non-editorial staff
- relations with reviewers and authors
- maintaining scientific and editorial standards
- budget planning and control

The Executive Editor is assisted in administration by an Associate Executive Editor and a Managing Editor; the Executive Editor reports to the Executive Director of the American Mathematical Society. The MR Editorial Committee provides Society overview and support in maintaining the scientific and editorial standards of MR.

The MR editorial office is located in Ann Arbor, Michigan, near the campus of the University of Michigan, and the editors enjoy many faculty privileges at the University. MR employs eleven associate editors, several consultants, and over sixty-five other full-time personnel. It publishes *Mathematical Reviews*, *Current Mathematical Publications*, special *Review* volumes and various *Indexes*. The major activity is the creation and maintenance of the MR database from which these publications and the online and CD-ROM service, MathSci, are produced.

The appointment will be for a negotiable period of from two to five years and should commence by September 1, 1990. The appointment has the possibility of renewal. Applications are welcomed from individuals taking leaves of absence from other positions; however, the Executive Editor position is full-time. Salary is negotiable and will be commensurate with experience. Generous benefits are available including study leave.

Nominations and applications (including curriculum vitae, bibliography, data on experience and names and addresses of at least three references) should be sent on or before **March 1, 1990** to:

Dr. William Jaco, Executive Director
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

The American Mathematical Society/Mathematical Reviews is an equal opportunity employer.

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AMS CONTINUES GROSS DISTORTION IN SURVEYS;
ABROGATES AGREEMENT WITH GORDON AND BREACH

New York — "The AMS has again published an erroneous and damaging survey," say officials of Gordon and Breach, Science Publishers, Inc., At the time of an earlier survey by AMS, Gordon and Breach pointed out many methodological and factual inaccuracies to the AMS. The AMS then agreed with Gordon and Breach that, because of the methodological problems, Gordon and Breach journals would not be included in any future surveys. The AMS Executive Director's exact words were "...I will of course see to it that G&B journals are not listed." This was reiterated in later correspondence with the European Mathematical Council. Yet, Gordon and Breach now appears in a 1989 AMS survey with many of the same inconsistencies and inaccurate conclusions about the price of its journals, due substantially to continuing the use of inaccurate methodology, which results in overstatement of Gordon and Breach's prices by as much as a factor of two.

Not only has the AMS engaged in factual misrepresentation, Gordon and Breach believes that it has broken all grounds of propriety in having breached the agreement not to include their journals in its surveys. In spite of its agreement, AMS personnel were apparently instructed to continue sending survey questionnaire to Gordon and Breach in which one would inevitably slip through. An earlier survey questionnaire was sent to our British affiliate some two years ago. Fortunately that one was caught, and when the questioner was informed about our agreement, the survey omitted our journals. Prior to publication of the recent survey, AMS again sent a questionnaire to Gordon and Breach. It unfortunately came to the attention of a new editor, who upon seeing the short deadline and the notation that the information would be deemed correct by AMS if there were no response, and being unaware of the prior agreement that Gordon and Breach would not be included in AMS' surveys, filled out part of the questionnaire. Obviously, his action does not waive the company's right to insist that AMS live up to its agreement not to include us in its surveys.

In the response the editor gave, he expressly listed three different prices we charge, one to corporations, a much lower one to libraries, and an even lower one to individuals. The corporate price included an optional 30% photocopy license and other factors not necessarily comparable to the other publications. The library prices also included an optional photocopy license and other factors. AMS, for reasons we cannot fathom, used only the highest corporate price rather than our much lower library price, even though the survey claims it was directed at libraries. Thus, even the information we provided was misused to produce the most damaging results. We believe it may have been done with intent, and we ask the AMS to publish a full retraction of our inclusion in their survey if this is not the case.

Additionally, the library prices which were used are our listed prices. Libraries regularly receive additional options, including a reduction if a photocopying license fee is not desired. Further, in 1988 Gordon and Breach granted an additional 15% reduction to all existing library subscribers renewing within a given time frame. Also, Gordon and Breach, unlike many other publishers, includes postage and handling as part of its price; a proper comparison to other journals should not include these costs. None of this is reflected in the AMS study.

The result is that AMS's calculation for cost per 1,000 characters is far off the mark. In effect, what the AMS has done is tantamount to comparing prices of the same automobile offered by a dealer which includes options and one which does not. Any survey that is not based on the unit price of a product results in an inaccurate and unfair comparison — "apples and oranges". If AMS were to have considered these factors, the cost per 1,000 characters for a journal such as *Applicable Analysis* in 1988 is 48 cents, rather than the 93.5 cents published in the survey. To give another example, *Complex Variables* is 26 cents rather than 52 cents.

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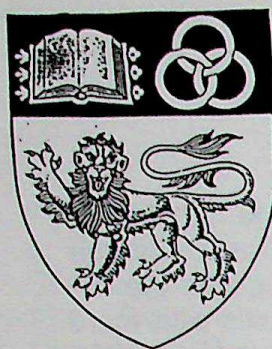
While basing its price survey on page and character counts, the AMS failed to mention the more fundamental difference that are reflected in subscription rates, such as the much lower potential market for specialized journals. This naturally leads one to question the usefulness of any survey which attempts to compare general circulation journals with more specialized ones. Leaving the factual errors about the Gordon and Breach journals aside for the moment, we will continue to question the logic of the AMS and other society publishers in resorting to such a narrow point of reference in comparing the value of research journals. For example, pre-press and production costs of different journals may vary significantly depending on a number of variables, like complexity of typesetting and other editorial services offered for different publishers. Gordon and Breach, for instance, provides help on the spot with copy preparation in countries like Japan and the Soviet Union. This is quite expensive. One of the journals included by the AMS in its survey, which the AMS stated was limited only to journals published in the United States, in fact originated in and was published in Europe, which affected its cost.

Gordon and Breach believes that surveys like that of the AMS necessarily reflect unfavorably upon the publishers of commercial publications as opposed to society publications. Of course the societies, which are generally non-profit and have tax-exempt status, can consistently price at a lower rate: membership dues, advertising, government grants and other forms of support insure that their subscription prices will be lower than those of a commercial publisher. But surveys based on cost just do not take into account benefits that commercial publishers, like Gordon and Breach, offer, benefits which may add to cost. These include, for example, the international breadth of the material included. In addition, publishing highly specialized journals, as Gordon and Breach typically does, necessarily results in higher costs per page but may ultimately be less expensive for the consumer, who will then need to subscribe to fewer journals. Therefore, to compare commercial and society publications is, in the opinion of Gordon and Breach, not only gratuitous but also blatantly unfair competition.

The problem with non-analytical surveys like this is that they do not really assess all of the factors involved in publication. For example, a publisher may publish a journal of high quality, having a limited audience; or he may have the policy of publishing a journal of low quality comprising material already covered by other publishers, and enjoy a wider number of subscribers. Our policy is to try to choose the best material regardless of the size of the market and produce and price as necessary. Other publishers may have a different approach.

We do not mean to suggest that we are alone in our philosophy, but when all publishers are taken together, whether they have government support or not, the results can become grossly distorted. If these distortions are used for purchasing decisions, the best quality research may well be ignored.

We welcome research and contribute frequently to discussion of issues pertaining to serial prices. In no way do we mean to inhibit such dialogue. All we are insisting on is accurate methodology of such surveys, or the same misguided selection process and/or criteria will be used time and time again, resulting in similar misrepresentations.



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Modern Perspectives of Mathematics:

Mathematics as a Consumer Good, Mathematics in Academia

March 29-31, 1990, Cornell University

The Mathematical Sciences Institute (MSI), Cornell University, is bringing together influential mathematics consumers, educators, and researchers for a 3-day examination of the nation's use and development of mathematics resources. Drawn from government policy agencies, academia, and business and industrial laboratories, they will address how to develop mathematics education and research in ways that will encourage the interplay of mathematics and its applications in business, industry, and government.

Lectures

Malvin H. Kalos, Cornell University, *The Impact of Computers on Mathematics*, (keynote address); **Edward E. David, Jr.**, EED, Inc., *Mathematics in a World of Mega Projects; Can it Survive?*; **Peter D. Lax**, Courant Institute of Mathematical Sciences, *Today's World and Mathematics*; **Jacques-Louis Lions**, Centre National d'Etudes Spatiales College de France, *Pure and Applied Mathematics*; **Ivars Peterson**, Science News, *The Mathematical Tourist*; **Shmuel Winograd**, IBM, *Mathematics and Computers*; **Roger W. Brockett**, Harvard University, *Mathematics of Intelligent Machines*; **Mary F. Wheeler**, Rice University, *Relationships between Industry and Academics*; **Walter W. Hollis**, U.S. Army, *Mathematics in Defense -- Support to the Decision Process -- A Subset*; **John J. Hopfield**, California Institute of Technology, *Mathematics in Neural Sciences*; **Michael E. Fisher**, University of Maryland, *Mathematical Rigor in Physics: To What End?*

Program Description

The symposium begins on Thursday, March 29, with registration, dinner, and the keynote address. Friday, March 30 will be devoted to lectures and discussion periods followed by an open, university lecture in the evening. The symposium will conclude with a panel discussion and a summary of recommendations on Saturday, March 31.

Panelists

Werner C. Rheinboldt (Panel Chair), University of Pittsburgh; **George Metakides**, ESPRIT; **Cathleen S. Morawetz**, Courant Institute of Mathematical Sciences; **Malcolm R. O'Neill**, U.S. Army; **Richard S. Stepleman**, Exxon Research and Engineering Company; **Rose Teukolsky**, Ithaca High School; **Daniel Willard**, U.S. Army.

General Information

The symposium will be held at Cornell University, Ithaca, NY. For information, contact conference secretary Diana Drake at the Mathematical Sciences Institute, Cornell University, 201 Caldwell Hall, Ithaca, NY 14853-2602, 607/255-7740.

Organizing Committee

Yervant Terzian (Committee Chair), Chairman, Department of Astronomy; **Wilson V. Kone**, Associate Director for Administration, Mathematical Sciences Institute; **Simon A. Levin**, Director, Center for Environmental Research; **Anil Nerode**, Director, Mathematical Sciences Institute; **Lars B. Wahlbin**, Associate Director for Research, Mathematical Sciences Institute; all of Cornell University. **Daniel Willard**, U.S. Army.

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IMA Summer Program RADAR AND SONAR

June 18 - June 29, 1990

ORGANIZERS

Alberto Grunbaum (chairman), Marvin Bernfeld, Richard E. Blahut, Richard Tolimieri

OUTLINE

Week 1, June 18-June 22, 1990 TUTORIAL

Lecturers: Richard E. Blahut, Willard Miller, Jr. and C.H. Wilcox

The first week will be run as a summer school. There will be three minicourses, each consisting of five-hours lectures. Lecture notes prepared by the lecturers will be distributed to students and participants as they arrive at the IMA. The minicourses are: TOPICS IN HARMONIC ANALYSIS WITH APPLICATIONS TO RADAR AND SONAR (Miller), SONAR AND RADAR ECHO STRUCTURE (Wilcox), and THEORY OF REMOTE SURVEILLANCE ALGORITHMS (Blahut).

Week 2, June 25-June 29, 1990 RESEARCH PROBLEMS

Scientists mostly from industry and government agencies who are working on problems in Radar or Sonar will present research problems. During this week, in addition to the audience of the first week, there will be other invited participants (mostly from universities) whose research is connected to Radar and Sonar.

Partial list of confirmed speakers and participants (in addition to organizers):

Eric Borden	Mostafa Kaveh	Harold Naparst	Robert Shore
Kevin Buckley	Bernard Levy	Joseph O'Sullivan	Murray Simon
Dennis Burnside	Peter Maass	Norman Owsley	Donald Snyder
E. Feig	Richard Marino	Craig Poling	Ahmed Tewfik
Izador Gertner	Medgyesi-Mitschang	Howard Resnikoff	Edward L. Titlebaum
Daniel Goodfellow	Gunter Meyer	Vladimir Rokhlin	Eric Walton
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Gary Hewer	Pierre Moulin	Luise Schuetz	Harper J. Whitehouse
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Some partial support is still available for researchers (including graduate students) who are, or wish to become, familiar with the subject. Preference will be given to those who participate in the entire program. For details write to Avner Friedman, Director, at the above address.

PARTICIPATING INSTITUTIONS: Georgia Institute of Technology, Indiana University, Iowa State University, Michigan State University, Northern Illinois University, Northwestern University, Ohio State University, Purdue University, University of Chicago, University of Cincinnati, University of Houston, University of Illinois (Chicago), University of Illinois (Urbana), University of Iowa, University of Michigan, University of Minnesota, University of Notre Dame, University of Pittsburgh, Wayne State University
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IMA Summer Program
NEW DIRECTIONS
IN
TIME SERIES ANALYSIS

July 2 - July 27, 1990

ORGANIZERS

Emanuel Parzen (chairman), David Brillinger, Murray Rosenblatt

Murad Taqqu, John Geweke, Peter E. Caines

OUTLINE

- Week 1, July 2-6, 1990 NON-LINEAR MODELS
Week 2, July 9-13, 1990 SELF-SIMILAR PROCESSES
& LONG-RANGE DEPENDENCE
Week 3, July 16-20, 1990 INTERACTIONS OF TIME SERIES & STATISTICS
Week 4, July 23-27, 1990 TIME SERIES RESEARCH
COMMON TO ENGINEERS & ECONOMISTS

Partial list of confirmed speakers and participants (in addition to organizers):

P. Arzberger	S. Durlauf	M. Kaveh	G. O'Brien	F. Sowell
F. Avram	K. Dzhaparidze	B. Kedem	H. Oodaira	J. Stock
P.M. Bleher	L. Fahrmeir	P.R. Kumar	G. Papanicolaou	T. S. Rao
P. Bloomfield	T. Fine	M. Lacey	J. Peyriere	D. Surgailis
P. J. Brockwell	R. V. Foutz	T.Z. Lai	G. Picci	G. Tauchen
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M. Casdagli	W. Gersch	K-S. Lii	M.L. Puri	D.B. Tjostheim
K.S. Chan	E. Ghysels	A. Lindquist	A. Raftery	H. Tong
H. F. Chen	G.B. Giannakis	A. Lo	G. Reinsel	K. Truong
R. Cioczek	A. Gombani	M. Maejima	J. Rissanen	R. Tsay
D. Cline	D. Guegan	P. Major	P. Robinson	J.K. Tugnait
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R. A. Davis	E.M. Hemerly	S. Meyn	J. Scargle	M. Watson
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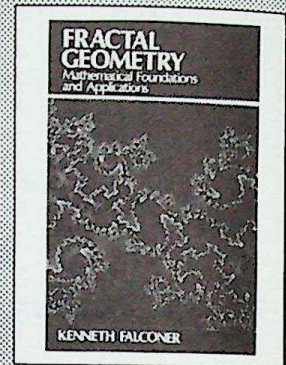
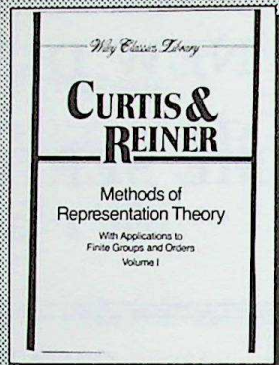
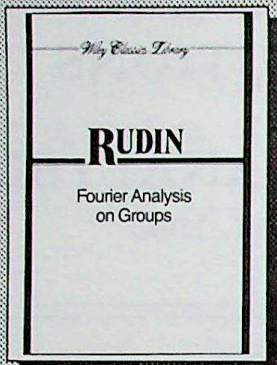
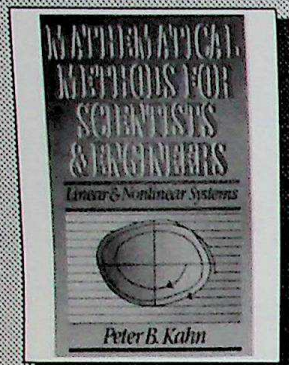
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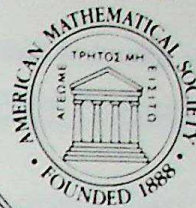
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INFORMAL LECTURES

J. Arthur	Formes automorphes	R. Moody	Universal central extensions and vertex representations
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For further information please contact: Ms. Sylvie Chênevert, CRM, Université de Montréal, C.P. 6128-A, Montréal, (Québec), Canada, H3C 3J7, Tel.: (514) 343-7501 or 343-2197, Fax: (514) 343-2254, e-mail: crmvis11@cc.umontreal.ca or crm@cc.umontreal.ca
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Letters to the Editor

Small Travel Grants

The November *Notices* (p. 1212-1213) reported on the discussion in the science policy committee about the idea of travel grants. Some of the comments given by members of that committee were so bizarre that a letter to the editor seems in order.

First off, most members of the AMS (but not apparently some members of the science policy committee) know how hard it is for all but the very best mathematicians at the very best places to stay alive mathematically—to stay informed about what is ‘happening’ in mathematics. Moreover, the vast majority of active mathematicians receive little or no encouragement that the research they are doing is worthwhile. The future ‘super stars’ among our undergraduates will probably go into mathematics regardless—but what about other, potential Ph.D.’s? Everyone agrees that we need to attract bright students to mathematics. Additional graduate fellowships or post-docs are less meaningful than one might think—if the teachers of these self-same students are honest and say: “Well you will get support for a few years but, unless you turn into a super star, you’ll get no help thereafter.” After all, consider how little hope even a “better than average” researcher has of receiving support. This is the point. Not ad hominem comments about who is or who is not worthy of a research grant.

Perhaps we should restrict these proposed travel grants to people who have not had a research grant in the last n years (pick your favorite value of n). Perhaps they should come out of the educational division in DMS. I neither know nor care. But I do know that something is seriously

wrong with the mathematical infrastructure in the United States and we had better do something about it—fast.

Some specific comments about concerns raised by members of the committee:

1. Travel grants will help mathematicians stay “mathematically alive”. This improves the infrastructure of mathematics in the U.S. (If properly pitched this is politically potent.) And, so is the “return on the investment” that McDonald asked about. Also pitched this way, Polking’s comments are also irrelevant as the grants are for “infrastructure” or “continuing education” rather than pure “research grants”.

The Association for Women in Mathematics currently administers a program similar to the one proposed (funded by NSF in fact). Obviously, sex plays no role except (given the extra problems faced by women in science) to explain why they had the idea first. It’s a good idea, period. Therefore:

2. Lipsman says the plan sounds like “welfare”. His comments are especially bizarre considering the kind of people who are not getting support. The cutoff is now so high that people who have won Sloan fellowships, continue to be active, can’t be assured of support. (Does he think that all women receiving travel grants from the NSF (via the AWM) are on “welfare”?)

3. Does Glimm mean to imply that everyone applying but not getting a grant is a “loser”? By this kind of reasoning the vast majority of mathematicians are “double losers”.

One needs super-highways—one also needs feeder roads. This is ultimately the reason for a small grants program.

Gary Cornell

University of Connecticut &
Visiting Scientist, IBM Watson Labs

(Received November 22, 1989)

In Allyn Jackson’s article “Science

Policy Committee Looks at Accreditation and Travel Grants,” several concerns about the implementation of a small travel grant program funded by the NSF were expressed. First, the Foundation expressed reservations about producing a class system among researchers, with those receiving travel grants constituting a “second class.” Second, there is the fear of spreading already inadequate funds too thinly, thereby detracting from the strength of the basic research enterprise in this country. Finally, some members of the Science Policy Committee opposed the plan on the grounds that it sounded like “welfare” and would create a group of “double losers.” While I fully agree that the second issue is a valid objection to what would be a costly program, I would like to cite the first

Policy on Letters to the Editor

Letters submitted for publication in *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule normally requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of *Notices* in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in *Bulletin of the American Mathematical Society* will be considered for publication. All published letters must include the name of the author.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, and will be acknowledged on receipt.

and third as examples of how the view from the top often gives us a distorted picture, and is not the only one that should be considered. (Fortunately, it appears that other members of the Committee have taken the broader view, and the plan is still alive.)

With over 19,000 working mathematicians unfunded in any way and, therefore, eligible at best for grants regarded as second-class, it is no wonder our profession is in trouble. From the position of most hard-working mathematicians trying to do research with little institutional funding and no hope of first-class support, a travel grant program is quite attractive. When (deservedly) well-funded mathematicians who probably have little idea of what life is like for most of the membership of the AMS decide that such grants would constitute welfare, they seriously undermine the integrity of their constituency. Let mathematicians make those decisions for themselves. Application is not, after all, mandatory.

The community already has one example of a successful travel grant program that is functioning on a much smaller scale than the AMS program would, but has in the past year provided partial support for twenty-five women with no other outside funding to attend research conferences in their fields. The Association for Women in Mathematics has a three-year grant from the NSF to award travel grants to women; while we have had to turn away more applicants than we would like, this disappointment is far outweighed by the pleasure of supporting these research efforts. We've had no complaints that those women who have received the grants feel like second-class citizens. The grants have not been difficult to administer, and the panels, meeting via conference call, have found the work rewarding. The response to this program is much greater than we expected, and demonstrates that (women) mathematicians need travel funds and are willing to apply for

them. If the AMS can convince the NSF to fund such a program without jeopardizing the basic research effort, I sincerely hope that the Science Policy Committee will see this as a most worthwhile program, affecting a wide range of mathematicians, and deserving of its most enthusiastic endorsement.

Rhonda J. Hughes
Past-President, AWM
Bryn Mawr College

(Received November 27, 1989)

Mentoring and the Mathematics Postdoc

As three 'mentored' postdocs, we were excited to read William Jaco's statement on the health of the postdoctoral program in mathematics. In particular, he points out that the mathematics community, in contrast to related disciplines, does not view the postdoc 'as a continuing education/training period' and that no active component of mentoring is generally found in a postdoc program. We feel fortunate to be postdocs at St. Olaf College where mentoring is an active component of the program. The situation at St. Olaf is perhaps the exception more than the rule, but we hope that this innovative program will serve as a model and an incentive to other colleges and universities.

The aim of this program is to help us develop as researchers and as teachers. Like postdocs in more traditional programs, we receive financial support for research (in the form of half of the normal teaching load, supported by a grant from the Fund for the Improvement of Post-Secondary Education), allowing us to expand our individual research programs. Unlike most postdocs, we have mentors who help us, primarily by facilitating our development as teachers. We meet weekly to discuss classroom issues, local and national curriculum reform trends, and the maintenance of a vibrant mathematics program. Other features of the program, designed to help with teaching, include student observers

and videotaping. St. Olaf is well qualified to carry out such a program; the department has a broad curriculum, as well as a very strong commitment to excellence in teaching, and the proximity to (and cooperation of) the University of Minnesota make a research library and seminars easily accessible.

We believe that mentoring should play a role for more postdocs and that mentored postdoc programs make sense at a wide range of institutions (at four year schools as well as at research universities). Nearly all mathematicians teach, and our discipline can only benefit if its new members are effective and stimulating teachers. A mentored postdoc program can also be used to attract Ph.D.'s from allied areas (such as statistics, computer science and operations research), who often have limited teaching experience, to teach in our undergraduate mathematics programs.

We hope to see a cooperation between undergraduate institutions, research universities, professional societies and funding agencies that will lead to a revitalization of the national mathematics postdoc program.

Steve Benson
Tim Hesterberg
Karen Saxe
St. Olaf College

(Received November 16, 1989)

Feminist Critiques of Science

The recent critiques of the "Feminist Critiques of Science" in the July/August 1989 issue of *Notices* prompt me to record a few observations.

1) In this era of indiscriminate articulation mathematicians are indeed among the most vulnerable and conspicuous targets for pent up sentiments let loose in the guise of sociological studies. Vulnerable, because communication with Mathematics is so delicate and intimate that it requires peace and privacy whether pursued by a team or isolation. Mystifying publicity or

stirs up grudges in those that feel left out. Serious expositions are a totally different matter. They do not need to resort to the human touch to appease or amuse the reader. Rather than any of the ordinary frailties it is the mathematician's total absorption, baffling enthusiasm and hidden sufferings that arouse envy and discomfort. But, most of all, the proverbially forbidding difficulty of Mathematics makes us both conspicuous and suspect. Family ties associate us with the notorious scapegoat "responsible" for all evils of technocracy. As if Mathematics and Physics had not for a long time been aware of their limitations in a very precise form!

2) Is there any need to bring in the dichotomy between "masculine" and "feminine" to confuse the issue of popular misconceptions about role, nature and claims of the sciences? Do we have to engage in debates? Can we not let our work speak for itself, show instead of discuss? How about educating the public by competent objective expository writing, without apologizing for difficulties and unresolved problems inherent in the subject matter?

3) To be sure, a woman in Mathematics has to face additional obstacles, from her colleagues as well as from the outside world. But that is a can of worms that I am not ready to open yet.

4) Would a girl, who thinks for herself and genuinely loves to do maths, let public opinion deter her from going into Mathematics?

5) What would be lost if only women motivated as in 4) were to choose Mathematics as a profession? In fact, is there any other valid reason for this choice? Might one of the causes for the scarcity of women among mathematicians be that women are less likely to choose a difficult career for wrong reasons like a craving for prestige or a need for a subterfuge from the more messy human endeavors?

Let me admit that I have just retired after "biting myself through" a variety of struggles (and mistakes) and that I feel as good about Mathematics as I did when I was 12. I still believe that the best a woman scientist can do for the women's cause is to do her own very best in her work. But I do feel now that I owe it to my students and colleagues to sort out my thoughts about women in mathematics. It is a maze, an intimidating maze.

Verena Huber-Dyson
Vancouver, B.C., Canada
(Received October 5, 1989)

I was pleased that *Notices* published the article entitled "Feminist Critiques of Science," by Allyn Jackson, in the July/August issue. The article describes a debate that has been ongoing between radical feminists and a number of scientists and mathematicians.

I agree with the comment by Anita Solow in her letter in the October issue of *Notices* that part of the problem is terminology. However, when radical feminists say that science is masculine, what people hear is that science is an activity done by men. If radical feminists mean that "... Western society has declared science to be masculine, not that women are inherently incapable of doing science," then that's what they should say. Calling science "male" only reinforces the societal stereotypes that women don't do science.

Robert Bix, in his letter in the Oct. issue of *Notices*, talks about ways in which women are discouraged from pursuing careers in science, and I agree with much of what he says. I wish that I could also agree with his contention that because the quotes from the radical feminists are short and not in context that they represent distortions. Unfortunately, some of the things I have heard are, if anything, more extreme and absurd.

At a conference on women and

computers, organized a few years ago by a women's studies department, the conference organizer asked the questions: What is feminist software? How would computers have developed differently had they been developed by women? This is another example of a problem of terminology. I inferred from later comments that the organizer had in mind good human factors when she talked about feminist software. I couldn't figure out the other portion of her question, but I think it has something to do with applications to which computers are put. (Presumably, she didn't mean that computers would be less phallic).

This is not to say that poor human factors are the only problems with software. There are a number of violent computer games, some of which tend to be off-putting to girls and women. (A particularly grotesque example is one in which the goal was to kill the Indian braves and rape the Indian maiden). But poor human factors, violent, racist, or sexist games, and ethical issues surrounding applications of technology should be confronted for what they are. It clouds the issue to talk about all science and technology in male/female terms.

My interpretation of most radical feminists who talk about science as being male is that they feel threatened by science and math, which they do not understand very well. Unfortunately, their view has received some acceptance by the mainstream feminist movement, most of the leaders of which are trained in the humanities. Consequently, we feminist scientists, who are working at getting more women into math, science, and engineering, are having our efforts sabotaged by people who claim to be helping us. Is it any wonder that some people are angry?

Barbara Simons
Almaden Research Center, IBM
(Received November 17, 1989)

Shigefumi Mori Awarded 1990 Cole Prize in Algebra

The Frank Nelson Cole Prize in Algebra is awarded every five years for a notable research memoir in algebra which has appeared during the previous five years. This prize, as well as the Frank Nelson Cole Prize in Number Theory, was founded in honor of Professor Frank Nelson Cole on the occasion of his retirement as Secretary of the American Mathematical Society after twenty-five years and as Editor-in-Chief of the Bulletin for twenty-one years. The original fund was donated by Professor Cole from moneys presented to him on his retirement. It has been augmented by contributions from members of the Society, including a gift made in 1929 by Charles A. Cole, Professor Cole's son, which more than doubled the size of the fund. In recent years, the Cole Prizes have been augmented by awards from the Leroy P. Steele Fund and currently amount to \$4,000.

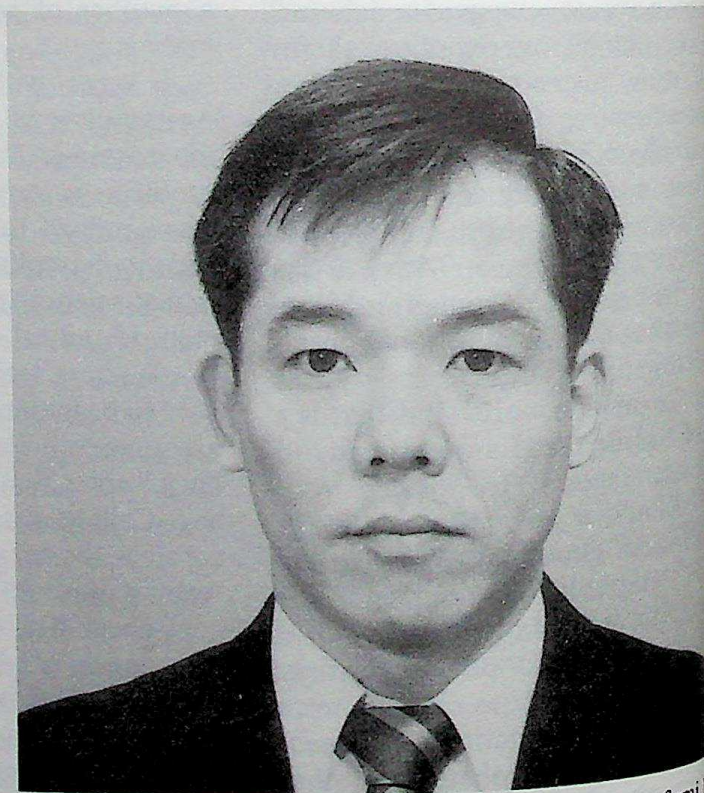
The Twenty-Third Cole Prize was awarded to SHIGEFUMI MORI of Nagoya University. The prize was awarded at the Society's ninety-sixth Annual Meeting in Louisville. The Cole Prize was awarded by the Council of the American Mathematical Society, acting through a selection committee consisting of Michael Artin, Walter Feit, and Melvin Hochster (Chairman).

The text below includes the Committee's citation and a brief biographical sketch of the recipient. Professor Mori was unable to attend the Annual Meeting to receive the prize in person. He did, however, send a written response to the award.

Citation

The Committee unanimously recommends that the 1990 Cole Prize in Algebra be awarded to Shigefumi Mori for his outstanding work on the classification of algebraic varieties. Mori took the decisive steps over a ten-year period in extending the classical theory of algebraic surfaces to dimension three: prior to Mori's breakthroughs this problem seemed out of reach. Mori's beautiful work also makes major inroads into the problem in higher dimensions. The committee notes, in particular, his paper, "Flip theorem and the existence of minimal models for 3-folds" in the first issue of the *Journal of the American*

Mathematical Society, January, 1988. In this paper Mori proves the existence of minimal models for three-folds which essentially finishes his program. Consequences include the analogue of Enriques' theorem (that if a plurigenera vanish then the variety is uniruled), the first generation of the canonical ring (this implies that three-folds of general type with given numerical invariants form a limited family — the first big step in constructing moduli), and the classification of Fano three-folds.



Shigefumi Mori

Response

I am greatly honored to have been awarded the Cole Prize for my paper on the 3-dimensional minimal models. I feel especially happy because much of my research has been done with the support of the cultural exchange between Japan and U.S.A. I am most grateful to the American Mathematical Society.

The new approach to 3-folds in the last decade originated from two directions; one was the extremal ray theory by myself which goes back to the Hironaka-Kleiman cone, and the other was the notion of terminal and canonical singularities introduced by M. Reid as 3-fold analogue of smooth and Du Val points on a surface. The latter arose naturally in the study of finitely generated canonical rings.

On the basis of these, the theory was developed along the lines of Reid's conjectures by X. Benveniste, Y. Kawamata, J. Kollár, V. V. Shokurov and others. The minimal model theory developed for threefolds actually works in arbitrary dimensions except for one key process called the "flip". For the (important but still special) semistable case of 3-folds, the flip process was done independently by S. Tsunoda, V. V. Shokurov, Y. Kawamata and myself. These approaches were different and my paper cited by the Cole Prize Committee finished the flip process based on Y. Kawamata's approach. At least for 3-folds, we can now start a systematic program of research. Typical results in this direction are the finite generation of canonical rings for 3-folds by T. Fujita, Y. Kawamata and X. Benveniste, the uniruledness of 3-folds with all plurigeners zero by Y. Miyaoka, and the study of surface singularities by J. Kollár and N. Shepherd-Barron.

What amazes me is the role of the anti-canonical divisors in this study, as pointed out by M. Reid in the case of 3-fold terminal singularities. At the current state of our knowledge, however, this role emerges only after a rather detailed classification of the singularities which occur. I hope one can understand this mystery someday and gain more insight in the higher dimensional case.

Biographical Sketch

Shigefumi Mori was born on February 23, 1951 in Nagoya, Japan. He received his B.A. (1973), M.A. (1975),

and Ph.D. (1978) all from Kyoto University. He wrote his thesis, "The endomorphism rings of some abelian varieties", under the direction of Masayoshi Nagata.

Professor Mori held the position of assistant at Kyoto University from 1975 to 1980. In 1980 he joined the faculty at Nagoya University as a lecturer and was promoted to associate professor in 1982. In 1988 he was promoted to his current position of full professor at that university. During this time, Mori also held visiting positions at Harvard University (1977-80 and spring, 1981), Institute for Advanced Study (1981-1982), Max Planck Institute (spring, 1982), Columbia University (1985-1987), and the University of Utah (summer, 1987 and fall, 1988). Under the U.S.-Japan cooperative program, he visited the University of Utah in fall, 1989.

Professor Mori is the editor of the *Nagoya Mathematical Journal* and *International Journal of Mathematics* and an associate editor for *Annals of Mathematics* and *Journal of Differential Geometry*.

In 1981, Professor Mori presented the C.I.M.E. Lecture Series, in Varenna, Italy. In 1983, he received the Japan Mathematical Society's Yanaga Prize and was an Invited Speaker at the International Congress of Mathematicians in Warsaw. He received the Chunichi Culture Prize in 1984. In 1988, he shared the Japan Mathematical Society's Fall Prize with Yujiro Kawamata for their "outstanding work in the minimal model theory for algebraic varieties"; and, in 1989, received the Inoue Prize for Science for his "outstanding work in the theory of higher dimensional algebraic varieties and in particular for the proof of existence of minimal models for 3-dimensional algebraic varieties".

COLORING THEORIES

Steve Fisk

(Contemporary Mathematics, Volume 103)

The focus of this work is the study of global properties of various kinds of colorings and maps of simplicial complexes. In addition to the usual sorts of coloring, the author studies colorings determined by groups, colorings based on regular polyhedra, and continuous colorings in finitely and infinitely many colors. The emphasis is on how all the colorings fit together, rather than on the existence of colorings or the number of colorings. Beginning with some fundamental properties of simplicial complexes and colorings, the author shows how colorings relate to various aspects of group theory, geometry, graph theory, and topology.

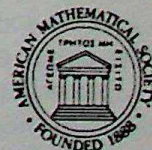
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Award for Distinguished Public Service Presented to Kenneth M. Hoffman

Proper recognition for mathematicians who contribute valuable service to the profession is a matter of great importance to the Society. The continued growth and health of the discipline is greatly dependent on those individuals who contribute their time to public service activities in support of mathematics. To provide encouragement and recognition for such service, the Council of the American Mathematical Society, responding to a recommendation from the Society's Committee on Science Policy, established the Award for Distinguished Public Service. The amount of the Award is \$2,500.

The Award is to be presented every two years to a research mathematician who has made a distinguished contribution to the mathematics profession through public service during the preceding five years. The first Award for Distinguished Public Service was presented to KENNETH M. HOFFMAN of the Massachusetts Institute of Technology and the Mathematical Sciences Education Board. The Award was made by the Council of the American Mathematical Society, acting through a selection committee consisting of Ronald G. Douglas, Robert M. Fossum (Chairman), John C. Polking, David P. Roselle, and David Sanchez.

The text below includes the Committee's citation, the recipient's response on presentation of the award, and a brief biographical sketch of the recipient.

Citation

The 1990 AMS Award for Distinguished Public Service is presented to Kenneth M. Hoffman for his outstanding leadership in establishing channels of communication between the mathematical community and makers of public policy as well as the general public.

After a distinguished career as a research mathematician, head of a major research department of mathematics, and other significant accomplishments in his university, Hoffman was instrumental in a host of major public policy achievements in the last decade. He was Executive Director of the Committee on Resources for the Mathematical Sciences (the David Committee) and was heavily involved in the formation of the Board

on Mathematical Sciences (BMS) and the Mathematical Sciences Education Board (MSEB), both activities of the National Research Council. He served as chair of the AMS Committee on Science Policy and later created the "Washington Presence" as the first head of the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics of the AMS, MAA, and SIAM. Through his efforts, the awareness of the importance of mathematics and the support of mathematical research has been significantly heightened in the general public among makers of science policy in the government, and among university administrators.



Kenneth M. Hoffman

Response

I am deeply honored to be the recipient of the Society's first Award for Distinguished Public Service. It has a greater meaning for me to have the Award presented

by Bill Browder, who was responsible for getting me involved with matters of public policy almost exactly 10 years ago. This involvement with the needs and responsibilities of our profession began when we were putting together Bill's brainchild, the first David Committee.

No working mathematician will be surprised if I say that when Bill asked me to become Executive Director of the David Committee I hadn't the slightest intention of staying in Washington for years, much less 10 years. But life has a way of choosing our careers for us. This career has turned out to be a fascinating and rewarding experience for me. In fact, I just signed on for another five year tour of duty to direct the Mathematical Sciences Education Board.

During the decade of the 80s, our relations with government and the public have changed in ways few of us even imagined in 1980. Our community has made its presence felt in policy circles as never before; we have begun to truly reach people through the media; and we have put in place lasting structures to better enable us to relate to our several publics—such structures as the Joint Policy Board, the Board on Mathematical Sciences, and the Mathematical Sciences Education Board. Out of these boards in 1989 and 1990 are flowing coordinated national game plans and strategies for revitalizing the mathematics research enterprise, the K-12 math education system, and the teaching of mathematics at the college-university level. It will be up to our broad community to implement these ambitious plans and strategies.

The growing group of colleagues who labor on your behalf in the vineyards of Washington has gotten the effort started. The fruits of their labors thus far include an increase in federal research funding for mathematics of 90% over the last six years, and placement of mathematics at the forefront of the national education reform effort now being led by the President and the governors.

If you're an analyst, as I am, you won't be surprised at the fact that you haven't felt the impact of the near doubling of research funding for our field. Any analyst knows that for all practical purposes, $2E$ behaves just like E —when E is very small. And we certainly started from a small research funding base. What we must keep firmly in mind over the next decade is the archimedean principle familiar to all mathematicians: no matter how small E may be, eventually NE gets large. In plain English, we have to stay the course set during the 80s—use the game plans and the structures that have been devised; get more of our colleagues involved; stick at it for another decade or more.

The leadership group responsible for initiating a new cycle of change in our community is quite sizable—much too large to receive a single award; and that's why I am up here. I've been lucky to sit somewhere near the middle of the action over the last decade, carrying out general plans

while serving as a combination catalytic coordinator and foot in the seat of the community's pants. This is not a role designed to make one popular, which is another reason this Award from the Society means a great deal to me.

I cannot take the time to thank individually the 100 or more key leaders from our community who should be standing here with me. This list includes a succession of Presidents and Executive Directors of AMS, MAA and SIAM; strings of division directors in federal agencies; and a battery of individual mathematicians who need no official position to provide leadership. To prune the list is to risk offending someone. Nevertheless, I feel compelled to express my personal thanks to several people with whom I have worked very closely and who have made all the difference for me at critical transition points: Bill Browder, Iz Singer, Jim Infante, David Fox, Hirsh Cohen, Bill LeVeque, Lynn Steen, Shirley Hill, Marcia Sward, Jennifer Vance, Kathleen Holmay, and my Washington mentor Ed David.

In addition, I want to thank my friend and colleague, Paul E. Gray, President of M.I.T., who has supported and continues to support my Washington involvement, using the principle that such involvement is part of my duties as a faculty member and part of the responsibilities of M.I.T. He has supplied more than half a million dollars to give practical meaning to that principle.

Finally, my thanks to the Selection Committee and the Executive Committee. Their task cannot have been an easy one, and I am pleased to have been selected.

Biographical Sketch

Born in 1930 in Long Beach, California, Kenneth Myron Hoffman received the A.B. in mathematics from Occidental College in Los Angeles in 1952. He was awarded the M.A. and Ph.D., both in mathematics, from the University of California at Los Angeles, in 1954 and 1956. He joined the staff of M.I.T. in 1956 as an instructor and in 1957 was appointed C.L.E. Moore Instructor. He was promoted to assistant professor in 1959 and to full professor in 1963. He became chairman of the Committee on Pure Mathematics in 1968 and in 1971 was appointed department head, a position he held for eight years.

Professor Hoffman has been a member of the M.I.T. faculty since 1959. Since 1981, he has been active at the interface of mathematics and public policy. From 1981 to 1984, he served as Executive Director of the Committee on Resources for the Mathematical Sciences of the National Research Council. This panel's 1984 report, "Renewing U.S. Mathematics: Critical Resource for the Future," is commonly known as "The David Report." It received nationwide press coverage and documented a serious imbalance between federal support for the math-

emational sciences and support for related fields of science and engineering. Hoffman was subsequently instrumental in the formation of two boards at the National Research Council, the Board on Mathematical Sciences and the Mathematical Sciences Education Board, of which he was a member from 1985 to 1988. He became Executive Director of the Mathematical Sciences Education Board on September 1, 1989, a position he holds concurrently with his M.I.T. professorship.

From 1981 to 1984, Hoffman was chairman of the Committee on Science Policy of the American Mathematical Society, and in 1984-1985 chairman of the Advisory Committee for Science and Engineering Education at the National Science Foundation. From 1984 to 1989 he headed the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics, which develops policy analyses on behalf of the national mathematics community and presents them to the executive and legislative branches of the government as well as to the public. This office led the effort to implement the recommendations of the 1984 David Report and is credited with the remarkable increase in media coverage of mathematics which has occurred in the United States in the past 5 years. In August, 1986, Hoffman was awarded the Public Service Award of the Joint Policy Board for Mathematics "for his far-sighted and effective initiation... of a national mathematical sciences policy."

In his eight years as a department head, Professor Hoffman further strengthened the mathematics faculty at M.I.T. He also created the position of Undergraduate Chairman, brought a strong statistics program into the department, and developed an affirmative action plan which became the national model for departmental plans.

Hoffman's main area of mathematical interest is function algebras, a subject which was discovered in the mid 1930's but lay dormant until the 1950's, when it was revived by Richard Arens, I.M. Singer, and their student, Kenneth Hoffman. They recognized the close relationship between Banach algebras and new developing approaches to complex analysis. The work of Hoffman at this interface represents a fundamental contribution to both complex and abstract analysis, two major branches of mathematics. Much subsequent research in this area has been based on the work of Hoffman's numerous research publications.

Professor Hoffman has taught mathematics courses from freshman calculus through advanced graduate courses and has written texts at all levels. He is co-author, with Ray Kunze, of the basic undergraduate text *Linear Algebra* (Prentice-Hall, 1961), which has been used widely throughout the world for nearly 30 years. Other books include *Fundamentals of Banach Algebras* (Instituto da Universidade do Parana, Curitiba, Brazil, 1962), *Analysis in Euclidean Space* (Prentice-Hall, 1971) and *Banach Spaces of Analytic Functions* (Prentice-Hall, 1967). For several years he also taught a special M.I.T. course on *Writing In and About Mathematics*.

Professor Hoffman was a Sloan Foundation Fellow, 1964-1966. He is a member and former Council member of both the American Mathematical Society and the American Association for the Advancement of Science. He is also a member of the Mathematical Association of America, the Society for Industrial and Applied Mathematics, the National Council of Teachers of Mathematics, the Association for Women in Mathematics, the American Statistical Association, the Institute of Mathematical Statistics, and the Operations Research Society of America.

ALGEBRAIC TOPOLOGY

Mark Mahowald and Stewart Priddy
(Contemporary Mathematics, Volume 96)

This book will provide readers with an overview of some of the major developments in current research in algebraic topology. Representing some of the leading researchers in the field, the book contains the proceedings of the International Conference on Algebraic Topology, held at Northwestern University in March, 1988. Several of the lectures at the conference were expository and will therefore appeal to topologists in a broad range of areas.

The primary emphasis of the book is on homotopy theory and its applications. The topics covered include elliptic cohomology, stable and unstable homotopy theory, classifying spaces, and equivariant homotopy and cohomology. Geometric topics—such as knot theory, divisors and configurations on surfaces, foliations, and Siegel spaces—are also discussed. Researchers wishing to follow current trends in algebraic topology will find this book a valuable resource.

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Computers and Mathematics

Edited by Jon Barwise

Editorial notes

I start off this month by admitting two embarrassing lapses.

Who developed those programs?

I have a set of guidelines I send out to software reviewers. One thing I forgot to mention in those guidelines was that a review should always indicate who developed the software. A couple of recent reviews have failed to do this, and readers have let me know about it in no uncertain terms. I regret these omissions and have added a new sentence to my guidelines.

One omission, ironically, was in the review of *Tarski's World* by Mark Seligman in the November 1989 issue. It happens that this logic courseware program was developed by John Etchemendy and me, with the support of the FAD program at Stanford University.

The other was in the review of *Exploring Small Groups* by Suzanne Molnar in the December 1989 issue. This program was developed by Ladnor Geissinger, who also wrote the manual. Geissinger is Professor of Mathematics at the University of North Carolina at Chapel Hill and a Fellow of the Institute for Academic Technology. He was given programming and technical support by an IBM/UNC software development project grant.

Correspondence

More on proving computer correctness

In the September 1989 column I wrote a piece reporting on a debate over proofs of program correctness. I also attempted to shed some light on that debate by appealing to the distinction between real world phenomena, and mathematical models of them. I analyzed the problem as a failure to distinguish carefully between the two.

By and large, the response to this article has been quite positive. A number of people in the program correctness community have said that it somehow managed to both shed light on, and cool, the controversy. By contrast, Richard Dudley of the M.I.T. mathematics department writes:

Program Verification

Barwise [1] reports on a discussion among philosophers, especially Fetzer [4], computer scientists, and now mathematicians.

can correctness of executable computer programs be proved? But essentially everyone agrees that it cannot be proved, in the strict mathematical sense, that a physical computer will execute a program correctly. A problem has been raised by use of the word "proof" about program verification. There is wide agreement that program verification is (currently) part of applied rather than pure mathematics, but mathematicians may well think of proofs as characteristic of pure mathematics. One might, for example, predict the orbit of a satellite very accurately without claiming to *prove* that it will be in a specific small region at a future time. I suppose very few applied mathematicians or scientists would claim to prove, in the sense of mathematical proof, anything about the physical world.

If, as Dobson and Randell [3] well say, "the hypothesis 'this program will execute correctly' is one that can never be proven, only falsified", and a 'proof' of a program's correctness shows "only that certain kinds of errors are not possible", then we are dealing with relatively weak, perhaps new (to mathematicians) meanings of "proof" and/or "correctness," which one should be clear about. Other central mathematical notions such as equality have acquired new meanings in computing: the computer-language equation $S = S + x$, where x is not 0, for example, in the context of a summation loop, might be understood as the mathematical equation $S(n) = S(n-1) + x(n)$, while in many computer languages " $S + x = S$ " is a syntax error.

On another point, actual programs are usually written in higher-level languages such as Fortran or C, then translated by a compiler or interpreter into a lower-level language and executed in connection with operating system software. Such systems programs may in turn have been written in higher-level languages and compiled by (another or partial) compiler. Systems software (and hardware) provide the environment about which Hoare [6] wrote: "Computer programming is an exact science in that all the properties of a program and all the consequences of executing it *in any given environment* can, in principle, be found out from the text of the program itself by means of purely deductive reasoning" [emphasis added]. Unfortunately Barwise [1] calls this a "famous quotation" but omits the phrase I emphasized, without even an ellipsis (...). Even if the misquote was found in another secondary source, the role of the environment should not have been overlooked. Fetzer [5] also mentions and criticizes the "famous passage" without noting the misquotation.

Fetzer [4] was, in turn, primarily a reaction to DeMillo, Lipton and Perlis [2], who said more or less that correctness of

programs was not being proved effectively in the 1970s because people were not checking others' proofs. Fetzer thought that one should go further and say that proofs of program correctness are not possible. For opinions in favor of such proofs both Fetzer [4,5] and Barwise [1] cite Hoare [6,7]. Fetzer [4] quoted selectively from Hoare [7], who did write:

"I hold the opinion that the construction of computer programs is a mathematical activity like the solution of differential equations, that programs can be derived from their specifications through mathematical insight, calculation, and proof, using algebraic laws as simple and elegant as those of elementary arithmetic . . . Computers are mathematical machines . . . computer programs are mathematical expressions . . . a programming language is a mathematical theory . . . programming is a mathematical activity."

But neither Fetzer nor Barwise tells us that Hoare [7] went on as follows:

"HOWEVER . . . [emphasis in original]

These are general philosophical and moral principles, but all the actual evidence is against them. Nothing is as I have described it, neither computers nor programs nor programming languages nor even programmers."

I'm afraid Barwise and Fetzer have done us a disservice by their incomplete quotations. But at the beginning of [4], Fetzer wrote "There are those, such as Hoare . . . who maintain that computer programming should strive to become more like mathematics." That, I believe, is a fair summary of what Hoare was actually saying, and it may be arguable, but in full and in context I think Hoare was addressing a question of what will work best in the future for computer programmers. Hoare [7], even according to one quote given in Fetzer [4, p. 1058] (but not Fetzer [5] or Barwise [1]) was negative about proofs of program correctness in typical current environments.

There are mathematically interesting and difficult issues in precisely deriving a program from its specifications. Even if the specification calls for evaluating a given polynomial, the results are non-unique since in current computer arithmetic addition, done to a fixed number of binary or decimal places, is not associative. It is unfortunate that these real issues were obscured in the philosophical discussion.

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Reply: I plead guilty to misquoting Hoare, omitting the phrase "in any given environment." I simply took the quote from Fetzer's article without checking the original. Fetzer tells me that

there was an elipsis in earlier versions of his article, but the somehow disappeared along the way. If the missing words were replaced, the ambiguity between the real world and the mathematical phenomena persists, since the term "environment" has two meanings. One reading would take it to be the actual environment in which a program is run on a physical computer. The other usage is where environments are certain abstract mathematical objects. Both are quite common in computer science. In terms of my analysis of the larger debate, the term "environment" is itself ambiguous between the physical environment and a mathematical model of it, or rather, of certain aspects of it omitted from the model of the computer itself. If we interpret all this in terms of the real thing, then Fetzer's argument about proving programs correct is impossible. If we interpret it as applying to the mathematical model, then it is possible, but not as useful as the fit between the model and the real thing. What Hoare had in mind, if he was in fact clear about the distinction, does not seem to be important. For the point of my piece was to attack or defend Hoare or Fetzer or anyone else, but to try to illuminate a controversial special case of applied mathematics.

Uses of computers in mathematics

This portion of the column is devoted to short articles detailing ways mathematicians have found to use computers in some aspect of mathematics: teaching, research, writing, . . . Readers are invited to submit articles to the editor: Jon Barwise, C-100, Ventura Hall, Stanford, CA 94305, or in L^AT_EX by email: barwise@csl.stanford.edu.

Computers in Mathematics at Lafayette College

Clifford A. Reiter and Thomas R. Yuster
Lafayette College

The computational environment at Lafayette is different than at Grinnell and the University of Wisconsin-Madison as described in this column by Gene Herman in May/June 1989 and Rod Smart in May/June 1989. Yet there are some obvious similarities in the hardware and infrastructure. You will see that our department is active in using computing in teaching but does not have the grand programs (yet). We have acquired most of our equipment with support from the college administration and Pennsylvania state grants. The department has been active in letting the administration know its needs. Lafayette College has just under 2000 full time undergraduate students and a small part time program but no graduate program. Engineering accounts for 30% of the student body. Computer Science is a separate department. The mathematics department has a full time faculty. About ten sections of the scientific sequence are taught each semester with 24 students

section typical. We graduate 10–15 mathematics majors each year.

Some Apple II Graphics:

The college maintained an HP3000 during the early part of the 1980s. Students in Differential Equations and Numerical Analysis were often expected to run or program examples of numerical techniques using Fortran on the mainframe. Computer graphics first entered the classroom when the department acquired an Apple II+ microcomputer. It was connected to two 19" monochrome monitors mounted on carts. We used Arb-Plot for various graphics demonstrations and Surfaces for Multivariable Calculus was used for plotting surfaces. Both these packages were from Conduit. The hardware setup was quite cumbersome, the two monitors split the students' attention, and instructors did not have flexibility in selecting options for the demonstrations. Color capabilities were missed by the department. Instructors wrote differential equations and partial differential equations graphics demonstrations. The speed of the Apple made it impossible to run some of the more computationally complex programs during class. The system was used infrequently and by only a few of the mathematics faculty. In 1984 another Apple II with cart displays was acquired. Two years later this second Apple was declared surplus equipment; it plunged 5 feet to its death before it could be hauled away.

APL in Linear Algebra:

In the fall of 1984, the department head at that time, Bill Jones, requested and received college support for providing APL (A Programming Language) to give linear algebra students experience with computational exercises. We used three IBM PC's and I. P. Sharp's APL/PC interpreter. We chose APL for these exercises since it was powerful, used a mathematical function like notation, and required little class time to be introduced. Some examples of the assignments given to students: discovering the convergence of stochastic matrices, least squares fitting to polynomials, and implementing and comparing the power method and the Rayleigh quotient iteration for estimating eigenvalues. At first, the students came to a classroom with student proctors at designated hours to use the software. The students had little difficulty completing the exercises and many had good first experiences using computers. Introducing assignments such as these required considerable effort on the part of the faculty—especially if they did not know APL. It is remarkable that several of our faculty who did not know APL made that effort.

Sharp's APL is a very good product—it handles complex arithmetic, has very fast binary arithmetic, and has enclosed arrays (a matrix can be an element of an array). It is somewhat slow for certain operations and it

does not come with a PC graphics interface. The APL character set was obtained by our replacing a chip on the monochrome display card. (Does anyone need an original IBM character ROM cheap?)

Student access to APL on these PCs was awkward at best. Fortunately, the college installed 17 IBM AT's during 1986 in public use areas and met the substantial cost of the APL licenses. These machines allowed the APL characters to be displayed via software and greatly improved accessibility for our students. This APL interpreter is still available but it is now shareware.

Ideas Program:

The Ben Franklin Consortium of schools in Pennsylvania ran the "Ideas" program during the summers of 1984–1986. The major goal of that program was the production, by educators, of educational software. Mark Michael and Tom Yuster participated and produced software for Topology and Abstract Algebra. Tom also wrote color graphics software for calculus demonstrations on the IBM PC. This eventually resulted in the package Calculus Graphics (Polygonal Press) which we now use extensively in our calculus sequence.

Color Graphics Demonstrations:

Near the end of 1986 we obtained a Sony Color Projection System (CGA resolution) in order to be able to do classroom demonstrations—primarily to run software written by Tom Yuster. We have the special pleasure of being able to bug the author to add the features we want (They delight in this – Tom) (You should have seen his original version – Cliff). We use this software for short classroom demonstrations and in laboratories. Examples are: graphically displaying Newton's method, numerical integration, plotting level curves, direction fields for first order differential equations, and Taylor polynomial approximations to functions (the radius of convergence is a simple idea once you have seen it illustrated graphically).

Again the department head, by this time Jim Crawford, made a case for the department's need for this equipment. We added a CGA graphics card and a mathematics coprocessor to an IBM PC to drive the projector. (Coprocessors should be standard equipment on computers used to do mathematics.) At first we worked with the projector and computer on separate wheeled tables. With careful wiring only a couple of connections were required. Faculty made more use of this system than they had of the previous system, but it was still more likely that an instructor would teach a section of calculus and not use the computer than it was that the computer would be used.

The next year we put the projector and computer onto a single cart with 5 inch rubber wheels. This change turned out to make a bigger difference in ease of use than one might have suspected. Normally the projection cart

is wheeled into the instructor's classroom for use. It takes about 2 minutes to plug in the cart, insert an appropriate diskette, throw the power switch, and position the cart for focusing. The usage of the system increased significantly. *Instructors are much more willing to use equipment when it is easy to use.* It is so easy to use that many times it has been used in one class during the beginning of an hour, rolled down the hallway at an agreed upon minute, and used in another class for the second half of the hour. Student response to demonstrations with the projector has been generally quite positive. See the following page for how we recently updated this projection system.

We have also used SURFACE PLOTTER by Elm Software for animating surfaces. The use of these animations has become increasingly popular among the instructors of our multivariate calculus course.

Some Faculty Machines:

During the academic year 1986-1987, the first few mathematics faculty were given PC's for their offices. We put together 3 computer systems using a Pennsylvania state instrumentation grant. These systems ended up being Zenith 159 computers with a hard disk, an EGA display card, and NEC multisync monitors. We actually ordered Zenith 158's and separate EGA cards. However, when the Zeniths arrived they were 159's with built in EGA cards. We still have the extra EGA cards we ordered. (We'll make you a package deal along with the IBM ROMs.) *One of the problems with piecing together a computer system is a change in one vendor's product can put the whole system at risk.* We were lucky that we ended up with better machines and extra display cards as our only "problem". Our experiences with the Zeniths have been very good.

More faculty have received machines on their desks over the past few years due to a program begun by the Provost. We now have an IBM compatible (mostly PS/2 50s) or a MacIntosh in every mathematics faculty office except one.

Word Processing:

Of course, faculty needed word processors. We searched for a technical word processor suitable for faculty and the department secretary in the fall of 1986. We selected TechWriter (CMI Software) because it provided support for the QMS Kiss Laser printer, it allowed user definition of special characters at full laser resolution, and it was already being used by some of the college's engineering departments. Because of our request for the laser printer, the department head had to shout at an administrator about how important it was for secretaries to have quiet offices. Of course, he was lectured on the horrendous costs of laser ownership. We got the printer.

TechWriter is a powerful word processing package. Its printer drivers are remarkably good. It is a markup

language with a carefully crafted editor in that marked up text rarely needs to be accessed. Its spell checker is intolerably slow and the entire package is dated since it doesn't support proportional or scaled fonts or graphics. We understand a major update is expected in 1990.

Several faculty and the secretary also use Wordperfect 5.0 for documents that do not contain mathematical equations. This has a very good spell checker, a thesaurus and is the college standard word processor.

A Computer Room:

In 1985 the mathematics department felt the need for a computer room in our building that could be used for teaching. The Mathematics and English departments combined their requests. In 1986, a combination of purchases and gifts from IBM provided a room with almost two dozen IBM ATs and a color EGA projection system. In 1988 the room was partitioned, the projection system was ceiling mounted, and the computers turned to face the projection screen. The room is now very useful for teaching in a laboratory environment. Occasionally calculus classes use the room for graphics exercises but it is now primarily used by the department for statistics a statistical package. Other departments use the room frequently.

Exercises in Probability and Statistics:

By 1986 some sections of our statistics course for non-majors used Minitab for a few practice exercises. The college obtained a SAS site license and the department was encouraged to switch to SAS. It is still using SAS. Typical computer exercises are creating histograms, computing sample statistics, graphing scatterplots, computing regression lines and correlation coefficients, sampling from various distributions to see the effects of sample size and the central limit theorem, computing confidence intervals, and hypotheses testing. Many of Lafayette's mathematics faculty have made considerable time investments in order to introduce computational exercises into the statistics courses. As the computer rooms on campus have become suitable for teaching, some of these exercises are being done as laboratory exercises in these rooms.

We have also used demonstration packages in statistics sequences. Henryka Komanska used *STATISTICS DISTRIBUTIONS* by Martin Richter of Lehigh University. It was developed as part of the Ideas program. The package was written by a Lafayette student. Evan Fisher used GASP (see this column, February 1989) for classroom presentations and general audience talks. These packages contain good simulation capabilities and GASP has some especially attractive graphics (if you like free

Colorful Printing:

The department projection system was limited by the fact that it provides only CGA level graphics. The EGA projector was ceiling mounted in a computer classroom. We felt the need for using higher quality graphics during lectures, but upgrading to a VGA system was not financially practical at that time. Moreover, a couple of faculty were creating images of chaotic systems and wanted to be able to display images on bulletin boards (you know, the cork kind). An HP PaintJet printer was attractive since it was capable of better than VGA resolution graphics and could be used both for creating color prints and overhead transparencies. Moreover, it only cost about \$1000. In fact, when we made the case for this printer to the department head he wrote a personal check. *If you need equipment, bug your Department Head.* You may not have the same success we had.

The printer came with a print screen utility that does a nice job printing EGA graphics. We also use ColoRIX VGA Paint for capturing, modifying and printing images. The printer has been used by faculty to create a number of graphics based talks. Color images posted on faculty office doors have engendered some considerable student interest. *High quality color fractal images are hard to beat if you want to attract students.* The printer has also been used by a couple of students doing research work. It is a highly valued resource.

Research with Students:

Lafayette is very committed to supporting undergraduate education. In recent years there has been a fine effort to support student research. Several mathematics faculty have become involved in such programs. Cliff Reiter worked with students on images from multidimensional chaotic systems and continued fractions, Tom Yuster worked with a student developing a graphing utility, Tom Wood worked with a student on Kalman Filtering, and Gary Gordon worked with a student on graph theoretic invariants. These projects all had computational aspects. This is not to suggest that we all become applied mathematicians or computer scientists. But *computational aspects of a faculty members specialty may well provide opportunities for research with undergraduates.*

Upgrading the Projection System:

The Sony projection system has been upgraded twice. First, in the fall of 1988 we added a VCR for showing video tapes. Switching between the computer and VCR requires throwing one switch. In the fall of 1989 we upgraded the PC which drives the projector. We added a 40MB Plus HardCard (this is a "drop in" hard disk). Of course, having the hard disk means using the projector in the classroom is easier. We also added an Intel InBoard 386/PC with a coprocessor. It was easy to install. This greatly speeds up the computations although the PC

takes longer to boot since there is more memory to check. See PC Week's October 2, 1989 issue for a long list of companies selling 386 accelerator cards. Lastly, we added a VGA card capable of outputting a video signal that the projector can accept. For a few hundred dollars we upgraded the projector from a CGA to an interlaced VGA system. We bought Willow Peripherals' VGA-TV card and their RGB and sync cable for connecting to the Sony Projector. The graphics are very good. The projection system has become so popular that we need a second system to alleviate conflicts. We expect to purchase a VGA (color mapped) Liquid Crystal Display projection system soon.

A 386 Computer:

During the summer of 1989 the department acquired an IBM PS2/70 to run Mathematica. The computer is fast, has a 120MB hard disk, and came with 2M of memory. We added 4M more of IBM memory which required taking out the floppy drive and the chassis holding the hard disk. We had to do that several times since one of the memory modules made a bad connection on the first attempt at installation. It is easy and fun to take apart the PC (That is Cliff talking. It is frightening to watch - Tom) but we do not understand why this memory was not installed at the factory. We also added a math coprocessor. That was nerve wracking - the (very flimsy) pins were bent a couple of times before it was installed.

We installed DOS 4.0 and have had no problems except with the keyboard redefinition used by TechWriter which wreaks havoc with the entire system. The computer is connected to a QMS 810 Postscript laser printer and to the HP PaintJet which gives the PC very good graphics printing capabilities. Mathematica was easy to install. For all the aggravations of installation this is a fast computer and a pleasure to use.

This machine is in a mathematics faculty room which is the only "fair" place to put it. It is inconvenient for faculty to learn Mathematica there. We hope to put Mathematica capable machines on all faculty desks. *Faculty need their computational tools on their desks so that they can learn to use them during low quality time.* (While the coffee brews, while you wait for TechWriter's spell checker, while you should be grading, etc.)

Mathematica:

The department has been interested in obtaining some symbolic calculating software for several years. The college has adopted an MS DOS standard for PC based instructional computing. Hence the department's request for the IBM discussed above to run Mathematica. We hope in the next 2 or 3 years to put machines which are capable of symbolic calculating on all mathematics faculty desks. Two more Mathematica capable 386 machines for individual faculty members were recently

made possible by a Pennsylvania state grant. They are on order. Steve Buyske, who has a MacIntosh at home, runs Mathematica on it to help with his research in Differential Geometry.

We are just learning how to use the Mathematica software – it is impressive. Mathematica provides a very powerful environment in which to work. It requires substantial effort to learn but it provides considerable computational punch for that effort. Informal timing tests of one and two variable factoring problems showed Mathematica on the PS/2 running 20 to 100 times faster than Reduce does on a Vax 750.

The graphics capabilities of Mathematica are very good. For example, doing a 3D color plot of the real part of $\sin(z)$ with 2500 points on the surface takes 45 seconds on the PS/2. It is a simple matter to get a black and white hardcopy of graphics on the PostScript printer and it is fairly simple to capture a VGA color image with ColoRIX VGA Paint and print it on the PaintJet. Mathematica uses color dithering schemes so it is hard to believe it is using only 16 colors – it looks like many more.

Networking:

The college at present has a Vax 750, a Vax 780, an AT&T 3B15 (Pizza Hut has one of these), and an IBM mainframe for academic computing. The department still has only one connection to these machines and it is used largely for electronic mail and news. Computer classrooms in the library and in the Computer Science department already have local networks. The department is just starting to make use of these classrooms.

The college wide token ring network is well under way. The plan is for every dorm room, office, classroom, and public site to be connected to the network. Several of the dorms have already been wired and each dorm room is provided with a PC to connect to the system. Printers, including lasers, are available on each floor. Our building is slated to be wired in the next month or two.

The Future Symbolic Calculus Classroom:

The department has endorsed the idea of introducing a computer laboratory experience into the calculus curriculum. This is to include numerical calculations, symbolic computations, and lots of graphics. We expect these exercises to provide an experience that involves exploration and discovery. Students and faculty will interact in a new setting. Laboratory reports will provide opportunities for students to write about their mathematical experiences and the laboratory problems should encourage discussion among students. We expect to provide students with a 75 minute laboratory each week which will replace one 50 minute lecture in the present course. We are working with the administration to find funding for the laboratory, for

the faculty equipment needed, and for the development of materials.

Such a project will place considerable demands on our faculty. Here is where our previous experience is of value to us. At this point all of our full time faculty have bought in to the idea that computing can and should play a significant role in mathematics education. If your faculty is similar to ours, this will not happen over night, it will take years. *Faculty have to convince themselves that appropriate introductions of computing into the curriculum have pedagogical value. They need time to make such decisions and to develop the necessary skills.*

Homework Assignments by Computer Mail

*Stephen B. Maurer**

Here's an effective use of computers that seems to have been tried. Your campus needs to be at least partly networked with network access relatively easy for both you and your students. The use is: make homework assignments by computer mail ("email"). I've done this for several years in all my classes, from precalculus to the "senior conference" for majors.

But why bother, you ask? It's easy enough to write the numbers of assigned problems on the board, or provide them in handouts (perhaps at the beginning of the semester) if you really don't think problems from the text are enough.

I have several answers. Most important, by using email, I can customize my assignments to what actually went on in class and thus don't feel compelled to go through the material so that everything needed for a prefabricated assignment has been covered. Better yet, if an interesting point or question comes up in class, I can create one or more problems that deal with that point directly. Of course, one could put such special problems on a handout given out next time, but then the impact of immediate response is lost. I try to post my assignments within an hour or two of class and make them due at the next class (or, in classes with homework due weekly, I give a bonus for handing them in at the next class).

Second, I find I annotate problems when I post them on email. Even problems from the text often deserve some comment or customization, but it would be a time consuming to do these things in class.

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Third, I find I start to include with the assignments a number of other things: announcements of tests or special lectures, elaboration of points I felt I did not explain well enough in class, information about careers for math majors, etc.

Fourth, I invite students to send me questions, comments, and complaints via email, for private response or public (as they wish). Prompted by their experience receiving email from me, some find this approach more agreeable than coming to my office or asking questions in class.

At Swarthmore, classes meet for just 13 weeks a semester, 2.5 hours/week. Email allows me to reserve all of this limited time for talking about mathematics.

What are the downsides? I have to spend a little time teaching students how to use the campus email system. (Except for first-term freshmen, maybe half already know how.) I refer them to the Computer Center's handout, give them another of my own, and meet with the most computer-adverse students myself. (Most computer systems allow for distribution lists for mailing and for private bulletin boards, which makes communication between and among professor and class relatively easy.) Second, some students never like having to log on several times a week, especially if the nearest public access area is far from their dorm. On the other hand, some other students (non-math types) have thanked me for forcing them to learn the mail system – they proceed to use it with their friends at schools around the country. Third, I end up spending more time making up assignments than I used to – but the tradeoff is that I make better assignments. But at least it's no physical inconvenience – I type fast and a networked computer sits in my office. Finally, to date the only type of messages email will send (at least here) is pure ASCII. What if I want to send a problem with complicated mathematics in it? I could write it in \TeX code and have students "compile" it at the other end, but this would add another layer of effort for them (remember, some are mathphobic). My solution is to introduce a few elements of \TeX (like underline for subscript), to format things as best I can, and to write out much more than I would usually (e.g., call a vector " \bar{x} ", or say that "in this assignment u, v, x are vectors"). It works out ok.

I'd be very pleased to hear suggestions from others who have used email for communication with their classes.

Reviews of Mathematical Software

Review of True BASIC, Inc. CALCULUS 3.0

Reviewed by J. R. Moschovakis^{1,2}

Y. Matsubara¹

G. B. White¹

The Kemeny/Kurtz Math Series of software includes True BASIC programs for computer assisted instruction in high school mathematics and one-variable calculus. This review focuses on the CALCULUS program, version 3.0 (now updated to 3.01 for the PC and 3.02 for the Macintosh), which we used in 1988-1989 at Occidental College to enhance the first two terms of the standard calculus sequence. The calculus routines were written by John G. Kemeny and the common user interface by Thomas E. Kurtz; both are Professors of Mathematics at Dartmouth College. The program, which is contained on one diskette, is meant to supplement (not replace) any standard text and hand-done homework; an instructor's guide with instructions for modifying the software and a supplementary student workbook may be obtained at extra cost.

The program is available for the IBM PC or PS/2 with 256K and a graphics adaptor, and for the Apple Macintosh, Commodore Amiga, and Atari ST with 512K. True BASIC, Inc. offers site licenses at \$350 for one type of computer and \$175 for the second; the per-copy cost is \$49.95 (due to increase to \$79.95 in 1990) but institutions receive a 40% discount on five to nine copies and a 60% discount on ten or more. We asked students to buy individual copies, then showed them how to make backup boot copies and print out the contents of the screen. With this minimal help from their instructors, most of our students were able to hand in hard copy for several assignments. Predictably, some students found this computer work useful and interesting while others resented it; we were pleased enough with the software to continue its use in 1989-1990.

The program is entirely menu driven. Each topic has several examples, a Help menu, and a Glossary menu which partially accesses a common nontechnical dictionary. Glossary entries can be altered; see the instructor's guide for details. We used mostly the *General* routine, which covers symbolic differentiation and

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²Thanks to Tony Chan, UCLA and MSRI for computer privileges.

graphing, and the *Areas* routine, which does numerical integration and the standard approximations (left- and right-endpoint, midpoint, trapezoidal, and Simpson's) and sketches the regions involved. Other topics are *Limits*, *Tangent*, *l'Hopital*, *Parametric*, *Taylor*, and *Differential Equations*.

It is easy to record a session to be played back later; short messages may be added in a transitory window which appears when Help is requested. (In theory one can add comments and repair errors by editing the resulting .trs file, but this is not particularly easy.) The prerecorded demonstrations *Limits* and *Parameters* are excellent.

Upon entering CALCULUS one sees a brief menu at the top of a screen divided into two square windows (for formulas and graphing, respectively) and a rectangular message window. Choosing the *General* topic produces a new menu including Options and Plot/Print in addition to the standard Glossary and Help. Under Options one may choose to enter a new function, pick an example from a given list, differentiate the current function (may be done repeatedly for second, third, etc. derivatives), or print a table of values of the current function. The Plot/Print menu allows one to graph or not to graph the current function (using different colors or styles of lines for the graphs of different functions), to print or not to print the formula for the current function, and to rescale the graph.

Functions and parameters are entered in a transitory dialog box which is fully editable; illegal entries produce helpful error messages. Built-in functions include trigonometric and inverse trigonometric, square root, exponential, and the natural logarithm. The booklet accompanying the software explains the (standard) functional notation. Numbers may be entered in fractional, decimal, or scientific notation, and may involve the constant π as in $(2*\pi)/3$; the $*$ is obligatory even when the intent would be clear without it. The program initially requests x -bounds for the graph of the first function; the Rescale option (essential when several functions are graphed on the same set of axes) allows one to revise these and to specify y -bounds as well.

We found the *General* routine particularly useful for illustrating the relationships among the graphs of a function and its first and second derivatives. While the cumbersome notation makes multiple derivatives hard to read, there is space in the formula window for students to compute these by hand on the hard copy; one could argue that this is good for them anyhow. A basic bug is that the program seems unaware that odd roots of negative numbers exist; thus only the positive part of the graph of $f(x) = x^{1/3}$ for x from -1 to 1 is shown even when Rescale is used to request y from -1 to 1. Another annoying limitation is that x and f are the only variable

and function symbols recognized, reinforcing the type student's prejudice in this direction.

The *Limits* routine produces decimal approximations (even when the limit is rational or π). The *A* routine uses partitions with ten or twenty subintervals ("single" or "double" approximation) to illustrate the relationship between a proper definite integral and numerical approximations. Errors are listed, making it easy to compare accuracy of methods. There is no way to request only the trapezoidal approximation, for example; once one chooses "Approximation" it's all or nothing. The axes are not labeled so it's easy to forget the interval of integration. There is no symbolic integration or provision for improper integrals.

The *Tangents* routine sketches one nonvertical tangent line at a time; a vertical tangent produces an error message. The *Minimum/Maximum* routine doesn't consistently label points of inflection, and can't handle $f(x) = x^{1/3}$ even on $[0,1]$. The *Parametric* routine shows some beautiful examples of polar graphs, though again it recognizes no independent variable but t . The *Taylor* routine gives the first four nontrivial terms of a Taylor expansion about zero and graphs the corresponding Taylor approximations together with the function. Least satisfactory is the *l'Hopital* routine, which works only in the $0/0$ case. The *Differential Equations* option gives general and particular solutions to linear homogeneous second order differential equations with constant coefficients.

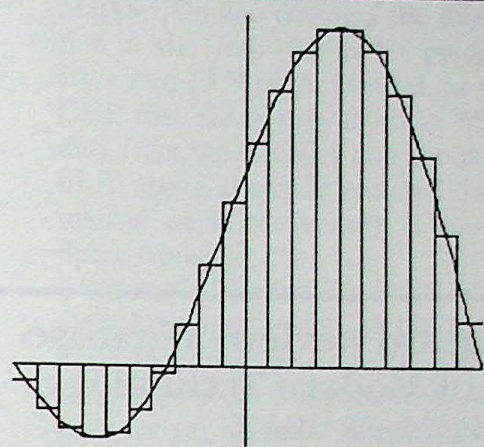
We hope that in a future edition the glossary entries which often lack rigor and sometimes are so abbreviated as to be confusing, will be improved. A few lines of instruction on screen printing for the Macintosh would be useful; while "caps lock, apple, 4" works with the Macintosh SE and a dot matrix printer, there seem to be difficulties with the Mac II. It would be nice to be able to print out only part of the screen (just the graph, for example); we weren't able to do this with an IBM PC. The *Differential Equations* routine could be improved by allowing arbitrary conditions, not just initial ones. A lot of space in the workbook is wasted on awkward uniform "graph paper" inserts; simple drawn axes would be more useful and less distracting. These considerations may be addressed in version 4.0, which is due out in the spring.

The bottom line is that True BASIC CALCULUS is a versatile, moderately priced, user friendly resource for one-variable calculus instruction. A conscientious student can learn a lot by exploring and questioning the results obtained using this software. A minimally computer-competent instructor can use it to generate large numbers of useful tables and graphs (for homework solutions, etc. as well as for class examples). Just don't ask it for the graph of $f(x) = \sin(1/x)$ when you are prepared to discuss the limitations of numerical methods!

Areas Routine for the Macintosh

Options Glossary Help

2:04

Calculus	Graphics																		
<p>Signed area between f and x-axis</p> <p>$f(x) = \sin(x) + \cos(x/2)$</p> <p>Area = 4</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Approximation</th> <th style="text-align: right;">Value</th> <th style="text-align: right;">Error</th> </tr> </thead> <tbody> <tr> <td>Left rect.:</td> <td style="text-align: right;">3.99177</td> <td style="text-align: right;">-.00823</td> </tr> <tr> <td>Right rect.:</td> <td style="text-align: right;">3.99177</td> <td style="text-align: right;">-.00823</td> </tr> <tr> <td>Trapezoid:</td> <td style="text-align: right;">3.99177</td> <td style="text-align: right;">-.00823</td> </tr> <tr> <td>Midpoint:</td> <td style="text-align: right;">4.00412</td> <td style="text-align: right;">.00412</td> </tr> <tr> <td>Simpson:</td> <td style="text-align: right;">4</td> <td style="text-align: right;">0</td> </tr> </tbody> </table> <p>(2/3 midpoint + 1/3 trapezoid)</p>	Approximation	Value	Error	Left rect.:	3.99177	-.00823	Right rect.:	3.99177	-.00823	Trapezoid:	3.99177	-.00823	Midpoint:	4.00412	.00412	Simpson:	4	0	
Approximation	Value	Error																	
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Midpoint:	4.00412	.00412																	
Simpson:	4	0																	
<p>Message</p> <p>An approximation of the area under a curve by rectangles whose upper (or lower if $f < 0$) sides have their midpoints on the curve.</p>																			

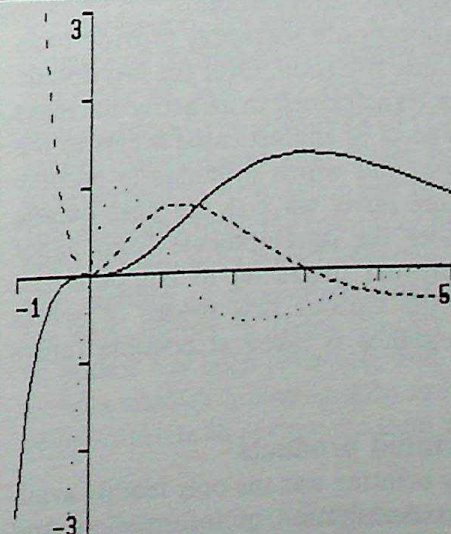
General Routine for the IBM PC

F1 Options

F2 Plot/Print

F3 Glossary

F10 Help

<p>General routine</p> <p>$f(x) = x^3 \exp(-x)$</p> <p>$f'(x) = -(x^3 \exp(-x)) + 3x^2 \exp(-x)$</p> <p>$f''(x) = 6x \exp(-x) + x^3 \exp(-x) - (6x^2 \exp(-x))$</p>	
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The second derivative $f''(x)$ is the derivative of the derivative $f'(x)$. If f'' is positive, the curve is concave upwards, if negative, it is concave downwards.

Inside the AMS

The Mathematical Reviews Database: The Power of Modern Technology

William B. Woolf

Introduction

Mathematical Reviews (MR) is traditionally thought of as a journal—one gets it in the mail or at the library, examines it to discover what is new in the literature in one's areas of interest, and then consults it (or its indexes) as the need for bibliographic references arises. Up until about a decade ago, that was all that it was: the information in MR was accessible only from the physical volumes. At the MR offices, bibliographic information was maintained only on cards or on ditto masters. Review manuscripts were assembled each month and sent off to a compositor in England for typesetting in hot lead. When an issue was printed, the hot lead was melted and no version of the information other than the printed issue remained, except for the original manuscripts and the card file of bibliographic information.

Computers (and appropriate software) provide tools for greatly improving this situation. Over the last decade or more, MR has been transformed to an active database which provides many sorts of sophisticated access to the traditional information, and which promises to become accessible in even more novel ways as the next decade progresses. In this note the developments from paper journal (and other printed products) to computerized database are traced, the various new modes of access are described, and a glance is taken at possible future developments.

Printed products

Because until recently printing was the only readily available method of mass distribution of information, and because users find different modes of access preferable for different purposes, MR has traditionally provided alternate printed versions of its information. Unfortunately, before the computer, many of these products required either a separate (costly) keyboarding of the

information into the new format (as in the case of indexes), or the laborious cutting and pasting of original reviews into special purpose collections (as in Review Volumes). Besides MR itself, these versions include:

MR Sections, which are personal-sized slices of MR containing the reviews—exactly as they appear in MR—that are in areas of interest to the subscriber. (Thirty-eight different classification sets are available.)

Current Mathematical Publications (CMP), a weekly journal containing the bibliographic descriptions of items as they arrive at the Ann Arbor office and are selected for review in MR (CMP also contains the listings of a substantial number of items that are not reviewed in MR). Semi-annual cumulative indexes aid in speeding larger searches. In addition, CMP contains reproductions of the tables of contents of many important journals, lists of recent books, etc.

Cumulative Indexes, prepared to assist users of MR in performing comprehensive searches of the literature, or in locating specific items from the past. Author indexes are available for the periods 1959–1964, 1965–1972. Subject indexes are available for 1940–1958 and 1959–1972. Combined Author and Subject Cumulative Indexes are available for the periods 1973–1979 and 1980–1984.

Review Volumes, which are collections of reviews in a specific subject area, covering a span of several years. These volumes are intended to help researchers survey the literature in a given field. AMS has published (in reverse order of publication) the following Review Volumes: Functional analysis (1980–1986), Operator theory (1980–1986), Complex analysis (1980–1986), Global analysis (1980–1986), Numerical analysis (1980–1986), Partial differential equations (1980–1986), K-theory (1940–1984), Number theory (1940–1972 and 1973–1983), Ring theory (1960–1979 and 1980–1984), Graph theory (1978), Finite groups (1940–1970), Infinite groups (1940–1970), and Algebraic and differential topology, topological groups, and homological algebra (1967).

The beginnings of computerization

Starting in the late 1970s, efforts were undertaken to computerize the MR operation. The first effort computerized the reviewer files (for the limited purpose of assisting the MR editors in the process of assigning articles to reviewers). The next effort, completed early in 1980, added a complete bibliographic database to an expanded reviewer database. These efforts were undertaken by the MR staff in Ann Arbor, using the Stanford Public Information Retrieval System (SPIRES) on the mainframe computers at the University of Michigan. In 1982-1983, the database was moved to a Codasyl-based database management system (DBMS) located on the DEC machines in the AMS offices in Providence. Information regarding each item is stored in various "fields" (author, title, language of the item, paging, classification, journal identifier, etc.) which allow selection of items on the basis of elements in the fields (for example, all English language papers on Riemann Surfaces published since 1979).

At about the same time (mid-1979), MR switched to a computerized typesetting system, which greatly simplified the creation of indexes; during the seventies, volume and annual indexes had been created by retyping the bibliographic information onto index sheets using IBM Selectric typewriters and then photographing those sheets. Starting in 1980, indexes were prepared by simply re-sorting the computer files from which the issues had been prepared. Data from 1973-1979 were input into computer files from which the 1973-1979 cumulative index was printed, and, later, data from 1959-1972 were input in order to create a cumulative subject index for 1959-1972; both of these efforts significantly expanded the scope of coverage by machine-readable bibliographic data. Unfortunately, since the typesetting system was proprietary, typeset output could be acquired only from the vendor. Starting in 1985, this restriction was eliminated by switching to \TeX as the typesetting language.

On-line versions

Starting in the early 1980s, these computerized files of bibliographic information were made available (under the name MathFile) to commercial distributors of bibliographic databases (Dialog, BRS, etc.) each of which accompanies the data with a sophisticated search and retrieval program which enables complicated compound queries of the data based on numerous data elements, such as author, title, classification, words in the review text, language of publication, journal name, year of publication, etc.

Recently the Society has changed the name of this service to MathSci to reflect the fact that it also includes data from Computing Reviews, the Guide to Computing

Literature, The Tukey and Ross Index to Statistics and Probability, and the Current Index to Statistics. This information is now available in several forms:

MathSci On-line contains the bibliographic information in MR from 1959 to the present, and the reviews from mid-1979 to the present, as well as the items in CMP that are not reviewed in MR. It also contains data from the statistics and computer science sources listed above. It can be accessed through various commercial database vendors (Dialog, BRS, European Space Agency).

MathSci Disc is a CD-ROM (Compact Disk-Read Only Memory) version of the last five years of MR and CMP, available from the AMS. It provides access from a personal computer without the connect-time costs (or per hit costs) which sometimes inhibit users from effective use of the on-line version.

MathSci Tape Loads allow academic or commercial installations to load the MathSci information on their mainframe computers and to provide access to that information along their local networks. The institution must provide the necessary retrieval software, which can be acquired commercially or developed on site.

Current developments

During 1989-1990, taking advantage of significant improvements in computer technology, the MR staff are undertaking a migration of the MR database to INGRES, a relational DBMS, on workstations at the MR offices in Ann Arbor. This version will include a significant expansion to support the acquisitions efforts of the MR Library (in 1989, MR handled 3,475 books and 8,166 journal issues). Specifically, as MR librarians review catalogues of publishers, searching for publications within the scope of MR, they can easily search files reporting which orders have already been placed; moreover, claims letters requesting journal issues or books which should have arrived in Ann Arbor but haven't can be generated automatically from the computer files (for checking, signing and mailing by a staff librarian). The new version will also include an integrated assigning function, allowing the MR editors to check quickly what other work by an author has been reviewed, and by whom, or whether authors cited in a bibliography are reviewers who might be appropriate to review the item in hand.

Expenses

As modern technology develops even more efficient means of distribution of technical information (e.g., CD-ROMs), it is tempting to believe that as a consequence the information in MR ought to be available at some greatly reduced price. Many people are surprised when they learn that the major fraction (about 90%) of the

costs of MR derives from the preparation of the data for the database, and that the actual costs of distribution of the data (whether for paper, printing and postage for the paper volume, for mastering and duplicating a compact disk, or for preparing a computer tape) are relatively minor. Data preparation activity, however, includes many expensive steps (for more detail on some of these steps, see the article "From Published Paper to MR Review: How Does it Happen?" in this column in the December, 1989 issue of *Notices*, pp. 1362–1365.):

The MR Library staff identifies, acquires, records and catalogs the books and journals which are the raw material entering the front end of the MR production pipeline (this labor-intensive effort is expensive, even if most publishers provide copies of their books or journals at no cost—or in exchange for a copy of some equivalently priced AMS publication).

The MR Editors scan each item for possible inclusion in MR and, for those selected, identify an appropriate treatment (e.g., include in the indexes only, use the author's summary, extract a portion from the introduction to the paper, or obtain a full review—in which case they must select a reviewer to whom to assign the item).

Staff prepare and input the bibliographic data for all covered items and produce review forms which are sent to the reviewers (or, in cases where the item is not to be reviewed, to which are affixed the selected summary or portion of the introduction). (Sending a book to an appropriate reviewer in Europe or Asia is expensive.)

Returned manuscripts of reviews (and other treatments) are copy-edited by the MR copyeditors, and then edited for mathematical content by the MR editors. Unreturned reviews (an expensive burden on this process) require reminder letters and, if that is unavailing, duplication and reassignment of the item.

Edited review manuscripts are sent to keyboarders in Providence or Ann Arbor, where they are input into T_EX source files. It is becoming increasingly common for reviewers to send their reviews to MR via electronic mail, following a prescribed format (for which see the reverse side of the table of contents page in any recent issue of MR).

Galleys produced from the T_EX files are proofread by both the copyeditors and the editors, and then corrected by the keyboarders.

Only at this stage, when camera-ready pages are produced from the Society's typesetting machine and sent to the printer, does the process turn specifically to the production of the printed journal; every earlier stage was as much a preparation for the electronic version of the database.

Funding

How is MR funded? Essentially all of its income comes from subscription fees for MR itself and for related products. Over its history the total expenses of creating those products have occasionally exceeded by as much as 5% or 10% the revenues generated by subscriptions, sometimes because of a conscious decision by the AMS Board of Trustees to hold the prices of MR down in order to facilitate broad distribution of this important service to the community. In these years, the deficits have been made up from the general funds of the Society. As various new means of distribution arise from technological advances, it remains essential that each user of the information somehow participate in the funding of its creation. The problem of determining pricing policies for the various products so as to accomplish this equitably is not an easy one; the AMS staff and Board of Trustees struggle with it regularly.

Future developments

As computer and document-handling technology advance, access to the information in Mathematical Reviews will continue to be made available to the mathematical community in forms taking advantage of the resulting increase in the efficiency and effectiveness of methods for information retrieval. Efforts are currently underway to examine the usefulness and economy of hypermedia techniques and of image-processing capabilities. As forms of electronic distribution of information develop, their utility for the distribution of MR, C_R and MathSci will be explored, with an eye to providing the most effective access to accurate and up-to-date information about the literature of mathematics.

Washington Outlook

This month's column is co-written by A. B. Willcox, who is acting director of the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics in Washington, D.C., and Hans J. Oser, who is a consultant to that Office.

By the time you read this the calendar will have advanced to 1990. Though not yet the beginning of the last decade of the century, it does mark the start of the 90s, and the occasion calls for a look back at some of the events of the 80s and some thoughts on how they influenced our professional lives. It is also quite appropriate, at this time, to provide you with a perspective of the work of the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics, an office that came into existence during this period and that has become a prominent actor on the Washington scene.

Highlights of the Decade

1. **1981** - The Mathematical Sciences Research Institute at UC-Berkeley and the Institute for Mathematics and its Applications at the University of Minneapolis are created with NSF support.
2. **1981** - The National Research Council of the NAS/NAE establishes a prestigious committee of scientists and engineers to review health and support of research in the mathematical sciences. Chairman is Edward E. David, Jr.
3. **1982** - The Browder Briefing Panel reports to the President's Science Adviser on research opportunities in mathematics, the first of six science panels.
4. **1983** - AMS, MAA, and SIAM create a nine-member joint executive action arm, the Joint Policy Board for Mathematics, JPBM, to begin implementation of the David Committee's recommendations.
5. **1984** - The David Report: "Renewing Mathematics: Critical Resource for the Future" presents a ten-year plan to redress the imbalance between support for mathematics and other fields of science.
6. **1984** - The National Research Council establishes the Board on Mathematical Sciences.

7. **1985** - The National Research Council establishes the Mathematical Sciences Education Board.
8. **1986** - JPBM establishes a Washington Office of Governmental and Public Affairs, OGPA, to start a "long-term, coordinated effort" in public information as recommended by the David Committee.
9. **1987** - SIAM celebrates its 35th Anniversary.
10. **1988** - 100 Years of American Mathematics - Celebrating the centennial of the American Mathematical Society.
11. **1989** - "Everybody Counts" - BMS/MSEB issue their first 'Report to the Nation', on the state of U. S. mathematics education from kindergarten through college.
12. **1990** - Update of the David Report scheduled for late Spring.
13. **1990** - "MS 2000", the "Second Report to the Nation" and concludes Project MS 2000.
14. **1990** - MAA celebrates its 75th Anniversary.

Federal Support of Mathematics in 1982 and 1990

	FY 82 (mill. \$)	FY 90 (mill. \$)	Incr. % curr. \$	Incr. % const. \$
Department of Defense				
AFOSR	6.70	16.50	146	86
ARO	6.00	12.00	100	51
ONR	10.60	12.20	15	-13
DARPA	-	9.50	NA	NA
NSA	-	3.00	NA	NA
Total DOD	23.30	53.20	128	73
Department of Energy	2.30	6.85	198	125
Other Agencies	2.00	1.00	-50	-62
Total Non NSF	27.60	61.05	121	67
NSF				
DMS	31.20	76.05	144	85
Other	3.00	10.00	233	152
Total NSF	34.20	86.05	152	90
Total	61.80	147.10	138	80

The Total Federal R&D Budget, for Comparison (billion \$)

Total Fed. Govt.	42.10	70.10	67	21
Defense Dept.	22.10	45.30	105	55

Footnote: The numbers in this table are taken from the AAAS Reports on R&D in FY 1989 and FY 1990, and the AAAS Special Report: R&D in the 1980s (by Albert H. Teich and Kathleen M. Gramp).

The National Science Foundation remained the dominant source of federal funding for mathematics research during the decade, with a fairly constant share of 55%. The fraction funded by the Department of Defense declined somewhat, but less severely had not DARPA and the National Security Agency substantially increased their support during this time. The Department of Energy also began to play a greater role in supporting research in mathematics.

The table conveys neither the dynamics of the annual budget process nor the changes in the nature of this federal support. The 1990 NSF mathematics budget, for example, contains a significant amount for the Science and Technology Centers which did not exist in 1982. Support from the DoD agencies has become more concentrated on mission-oriented projects, influenced by the arms build-up and the strategic defense initiative. The mathematics community reacted strongly, yet rather un-evenly, to this trend.

The anticipated winding down of the defense budget in coming years creates uncertainty about the amount and nature of future support from DoD. Our community needs to be aware of that. On the other hand, a reappraisal of the long-term goals of the defense agencies may lead to a broadening of their research horizons. Those active in mathematics research in the early 1950s remember when ONR was by far the most generous source of funding for pure mathematics in the defense department.

A significant change from the 1960s and 1970s was the ascendance of the U.S. Congress. Highly competent technical staffs were added to the committees, and the Office of Technology Assessment acquired strong leadership during the past decade. One message from Congress in 1989 was loud and clear: we must provide a first-rate education in mathematics, science, and engineering for our youth from kindergarten through college, in order to prepare our young for technical careers in coming decades. This realization repeatedly led Congress to boost the budget for science education beyond the administration's requests.

From the dollar figures it would appear that the 1980s were a golden decade for mathematics. Yet, the number of individual research grants has not grown, and the prospects for entering mathematicians to obtain sustained research funding are actually worse now than they were in 1980. Also, the overall NSF budget has grown

less rapidly than the mathematics budget which points to increasing budget competition from the other disciplines in the future. The deficit reduction imperative already seems to have stalled the administration's ambitious plan to double the Foundation's budget over a five-year period. It is clear now that support for mathematics in fiscal year 1990 will barely stay ahead of inflation. The other sciences are in the same boat. Deficit reduction is important, but the health of the nation's scientific enterprise is vital to our economic future. The mathematical community will have to pay closer attention to the legislative process.

Joint Policy Board for Mathematics

The Joint Policy Board for Mathematics (JPBM) was formed in 1983 by AMS, MAA, and SIAM. The major purpose of this board was "to develop areas of common interest to the mathematical community, to interpret and publicize mathematics and its goals to policy makers in government, foundations and associations, and to communicate concerns of these external entities back to mathematicians as a basis for articulating goals and policies to achieve these goals".

By creating this nine-member joint executive arm, the three societies intended to provide a mechanism for coordinated implementation of the first David Report. By 1986, JPBM opened the Office of Governmental and Public Affairs (OGPA) in Washington. One of the first visible actions was to launch what has now become an annual event, a national Mathematics Awareness Week (MAW), following a Congressional Resolution that year. That resolution did not just happen; it was carefully considered through the legislative process by Kenneth Hoffman and Jennifer Vance (then OGPA's congressional consultant) and James Murphy, the AAAS Congressional Fellow sponsored by the three JPBM member societies.

It is unfortunate that budgetary constraints forced the three societies to terminate their support for the Congressional Fellows program. The Congressional experience can be valuable for one who decides to take a break at mid-career to find out what drives the scientific enterprise in Washington.

The JPBM created a public information department of OGPA under Kathleen Holmay. She has been the focus for the publicity about Mathematics Awareness Week and has, through well-crafted press releases and a carefully assembled network of science writers, brought about a major change in reporting by the national media on mathematics activities. We now have the national press attending our annual meetings, we hold special press briefings for reporters, and we have launched an annual JPBM Communications Award, which is given to an individual for distinguished reporting on mathematics to the general public.

Congressional liaison is the responsibility of one of the authors, Hans Oser, a part-time consultant to OGPA. He monitors progress of legislation affecting mathematics, covers hearings on science policy, keeps track of federal science budgets, and reports on what he learns in these pages. He also sends his weekly "TIDBITS from Washington" to the JPBM member societies.

After Kenneth Hoffman's move to the Mathematical Sciences Education Board (MSEB), Alfred Willcox, retiring MAA Executive Director, took over as Interim Director of OGPA. His mission is to lead OGPA through a move from the offices of the National Academy of Sciences to a suite in the MAA headquarters complex,

maintain and increase the momentum developed by Hoffman through the Spring of 1990 and assist in the transition to new leadership.

OGPA expects to increase its liaison activities on Capitol Hill and to become pro-active, rather than reactive, in monitoring the legislative agenda on matters affecting mathematics. We cannot do this alone, and we will have to call more often on the leaders of the societies to bring the concerns of mathematics to the attention of the executive and legislative leaders of our nation.

We always enjoy hearing from you. Our telephone number is 202-234-9570, or we can be reached by email (jpbm@athena.umd.edu).



American Mathematical Society

Manager Russian Translation Program Position Open

The Society is seeking applications from individuals with a broad-based background in mathematics and fluent Russian. Publishing experience or participation in a translation program would be helpful.

The manager will be expected to provide long-range planning for the translation program. Responsibilities will include identifying and developing real or potential projects and authors, acting as liaison between consultants and the Translation Editorial Committee, serving as the interface between the Society and appropriate Soviet agencies and publishing houses, and directing the activities of the translations editorial staff.

The person selected will work in the Society's Providence Office. Travel to the Soviet Union will be necessary.

Applications should be sent to:

Director of Publications
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

The Society is an equal opportunity employer and has a generous fringe-benefit program including TIAA/CREF.

News and Announcements

Math Awareness Week 1990

This year, Mathematics Awareness Week will be held April 22-28, 1990. This national event gives the mathematical sciences community an opportunity to celebrate mathematics and communicate to the public the importance, relevance, and beauty of the discipline.

The Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics is coordinating a variety of Math Awareness Week activities. This year's theme is "Communicating Mathematics." The activities are coordinated with the Year of National Dialogue, a series of events centered on discussion of the state of American mathematics and education.

During Math Awareness Week last year, a range of activities were organized around the country. For example, Columbia University offered a series of public colloquia on Recent Advances in Pure and Applied Mathematics to mathematics teachers, professors, and undergraduate and graduate students. At the University of Michigan in Flint, there was a mathematical poster contest that drew over 250 entries from 40 public and private schools. "Math-Conn '89" was a day-long program for 200 seventh and eighth grade girls, held at Cedar Crest College in Allentown, Pennsylvania. There were group sessions with women who work in math-related fields and presentations by two prominent women mathematicians. Many other schools, colleges, and universities organized

successful programs.

For more information about ideas for celebrating Math Awareness Week in your area, contact the Office of Governmental and Public Affairs, Joint Policy Board for Mathematics, 1529 Eighteenth Street NW, Washington, DC 20036; telephone: 202-234-9570.

New Soviet Math Institute Planned

The government of the U.S.S.R. recently decided to organize an international institute for advanced studies in mathematics and its applications. Named after the mathematician and physicist Leonhard Euler, the Euler Mathematical Institute will be based in Leningrad and will commence its activities during the 1990-1991 year.

One goal of the Institute is to extend the cooperation between the Soviet and international mathematical communities. The Institute is to function as follows. Each scientific year will consist of three trimesters followed by workshops. The programs of the trimesters will be determined in advance by an International Advisory Board. The Institute will invite foreign and Soviet mathematicians for joint work, consisting of collective and individual research, discussions, seminars, lectures, etc. The Institute will also publish a journal, *Transactions of the Euler Mathematical Institute*.

Leningrad authorities have provided the Institute with appropriate land, a building (now being restored), and fifteen apartments for visitors. The Soviet government has provided

a modest fund to furnish the Institute with modern word processors and copying facilities. Organizers also expect to have FAX services available when the Institute opens and eventually, electronic mail facilities. In addition, the scientific program will be coordinated with those of other centers of international mathematical research, such as IHES in France, MSRI in the U.S., the Mittag-Leffler Institute in Sweden, the Max Planck Institute in West Germany, and RIMS in Japan.

For more information, contact D. Fadeev, Director-Organizer, Euler Mathematical Institute, Leningrad 11, Fontanka 27, U.S.S.R. 191011.

Fulbright Scholars Announced

The Council for International Exchange of Scholars (CIES) has announced the names of approximately 1000 American scholars who have been awarded Fulbright grants to lecture or conduct research abroad. During the 1989-1990 academic year, these scholars will hold various appointments in about 100 countries around the world. CIES, an affiliate of the American Council of Learned Societies, cooperates with the United States Information Agency in administering the Fulbright program.

Listed below are the names of this year's Fulbright scholars in mathematics and in computer science. Following each name is the individual's home institution, his or her research area, and the country to be visited.

Mathematics: DEANE ARGANBRIGHT, Whitworth College

mathematics and computer science, New Guinea; SHRIKANT I. BANGDI-WALA, University of North Carolina-Chapel Hill, biostatistics, Costa Rica; STAVROS N. BUSENBERG, Harvey Mudd College, mathematics problem-solving clinic, New Zealand; JAMES E. FALK, George Washington University, optimization methods and applications, Czechoslovakia; LOUIS GORDON, University of Southern California, Los Angeles, sequential methods for nonparametric detection of a change in distribution, Israel; OMAR B. HIJAB, Temple University, problems in filtering and control, Jordan; RALPH N. MCKENZIE, University of California at Berkeley, classification of varieties, Australia; PAUL C. SHIELDS, University of Toledo, ergodic theory and its applications, Hungary; GERARD A. VENEMA, Calvin College, topology of 4-manifolds, Yugoslavia; ANDREW J. VINCE, University of Florida, mathematics and computer science, Malawi; JAMES E. WARD, Bowdoin College, mathematics, Lesotho; JOSEPH E. YUKICH, Lehigh University, probability theory, France.

Computer science: ALKIVIADIS G. AKRITAS, University of Kansas, computer algebra, U.S.S.R.; DAVID W. CLAY, Florida Institute of Technology, computer science, Lesotho; M. DEAN FENTON, Pennsylvania State University, computer science, Liberia; RONALD ROBERT GOFORTH, University of Arkansas, computer science and computer-based service applications, Fiji; AMAR MUKHERJEE, University of Central Florida, computer science, India; SYED SHAHABUDDIN, Central Michigan University, computer information technology and underdeveloped countries: a case study of Pakistan, Pakistan; PETER B. VON MERTENS, Lesley College, computers as tools for management, Tanzania.

For information on applying for Fulbright awards, write to: Council for International Exchange of Scholars, Eleven Dupont Circle, Suite 300, Washington, DC 20036-1257.

Australian Math Society Award

Michael Cowling of the University of New South Wales was awarded the 1989 Australian Mathematical Society Medal at the Society's meeting in July, 1989. The citation for the medal read:

"Michael George Cowling is a harmonic analyst of great distinction who first achieved international fame for his beautiful solution and explanation of the Kunze-Stein phenomenon. Subsequently he has applied transference techniques in an original way in the study of Fourier multipliers, has cleverly exploited fractional integrals in the estimation of maximal functions, and, together with Haagerup, has deepened our understanding of lattice structure in Lie groups. His work is characterized by a combination of the fine skills of a classical analyst with the penetrating insight of an abstract structuralist."

Math Communications Award to Playwright

Hugh Whitmore, a playwright, has received the second annual Communications Award from the Joint Policy Board for Mathematics. The award recognizes Whitmore's contribution to communicating mathematics to the public in his play, "Breaking the Code," which chronicles the brilliant but troubled life of the British mathematician Alan Turing. Turing, a logician who was largely responsible for breaking the German code during World War II, developed the important concept of a Turing machine, which set the foundation for the creation of the modern digital computer.

At the Joint Mathematics Meetings in Louisville last month, officers and executive directors of the AMS, the Mathematical Association of America (MAA), and the Society for Industrial and Applied Mathematics (SIAM) joined with other leaders in the mathematical community to honor Whitmore. The Communications Award consists of a citation and \$1000. The host for

the ceremony was Peter Hilton of the State University of New York at Binghamton, who worked with Turing in England at the time when Turing was decyphering messages from the German Enigma machine.

A former student of London's Royal Academy, Whitmore was an actor before he became a playwright, and his first stage play was produced in London in 1977. With the well-known actor Derek Jacobi playing Turing, "Breaking the Code" had a successful run in London's West End and on Broadway. Whitmore has written many plays for British television and has worked extensively for the cinema.

The Joint Policy Board for Mathematics is the public affairs arm of the AMS, the MAA, and SIAM. Last year's Communications Award went to James Gleick for his best-selling book, *Chaos: Making a New Science*.

MSEB Awards Grants for Math Coalitions

The Mathematical Sciences Education Board (MSEB) of the National Research Council has made awards of approximately \$10,000 each to twenty-five organizations for the planning of state mathematics coalitions. As the administrator of one of the grants, the AMS will be involved in the formation of a mathematics coalition in the Society's home state of Rhode Island.

The awards, funded by a major grant from the Exxon Education Foundation, with additional support from the Carnegie Corporation of New York, constitute the first phase of an effort to establish a coalition in each state to improve the quality of mathematics teaching and learning. The coalitions are designed to promote state and local actions that will move curriculum, instruction, and assessment toward the goals proposed in two recent reports, *Everybody Counts*, published by the National Research Council, and *Curriculum and Evaluation Standards for School Mathematics*, published

by the National Council of Teachers of Mathematics.

According to Robert Kansky, the MSEB project officer in charge of the state coalitions, the program is "designed to bring together educators, business representatives, and developers of public policy for the purpose of 'thinking nationally but acting locally' in developing mathematics programs tailored to state and local needs." The objectives of the coalitions include helping to communicate the specifics of proposed changes in mathematics education, stimulating development of state goals compatible with national ones, and promoting adoption of policies which foster long-term improvement.

The states receiving planning grants are: Arizona, California, Colorado, Georgia, Idaho, Illinois, Kansas, Kentucky, Louisiana, Massachusetts, Missouri, Montana, Nebraska, New Hampshire, New Mexico, Ohio, Oregon, Rhode Island, South Carolina, Utah, Vermont, Washington, Wisconsin, West Virginia, and Wyoming.

The project in which the AMS is involved, the Rhode Island Mathematical Sciences Education Board (RIMSEB), is headed by James T. Sedlock, professor of mathematics at Rhode Island College. The grant will support planning activities to formulate a permanent RIMSEB that will act as a focal point for various constituencies having an interest in improving mathematics education and as a resource for information about local and national issues pertaining to mathematics education.

As the parent organization for RIMSEB, the AMS will provide meeting facilities and support for the planning activities and will administer the grant. In addition, two AMS staff members are on the RIMSEB planning committee, William H. Jaco, AMS Executive Director, and James W. Maxwell, AMS Associate Executive Director.

This year, the Washington, DC-based MSEB hopes to offer funding

for implementation grants to support first-year activities of established state mathematics coalitions. These multi-year grants will be used to launch projects that would eventually be supported entirely by non-MSEB sources. For more information about the MSEB State Mathematics Coalitions Project, contact Robert J. Kansky, Senior Project Officer, Mathematical Sciences Education Board, 818 Connecticut Ave., NW, Suite 500, Washington, DC 20006; telephone: 202-334-1486.

Leitzel Named to NSF Post

Joan Leitzel, a mathematician and associate provost at Ohio State University, has been named as the director of the Division for Materials Development, Research, and Informal Science Education at the National Science Foundation (NSF). She began the NSF position on January 1.

In this position, Leitzel oversees four NSF educational programs funding projects primarily at the pre-college level: Applications of Advanced Technologies, Informal Science Education, Instructional Materials Development, and Research in Teaching and Learning. These programs comprise a staff of ten professional scientists who act as program directors and ten support personnel; the budget for fiscal year 1989 was \$44 million.

Leitzel says that increasing the involvement of research mathematicians in educational issues is "very important." "A lot of progress has been made in bringing the NSF's research directorates and education directorate closer together on issues of common importance," she notes. "That will be a goal for me at the NSF." She also is enthusiastic about the opportunity to play a role in science and engineering education at a time when national interest in education is high.

After receiving her Ph.D. in mathematics in 1965 from Indiana University, Leitzel went to Ohio State, where she has been ever since. She

served as vice-chair and acting chair of the department of mathematics before being named associate provost in 1985. Her plan is to return to the faculty of Ohio State some time in the future.

As associate provost, Leitzel has had considerable administrative experience that will assist her in her NSF post. Her responsibilities included overseeing instruction and curriculum, which entailed university-wide review of the undergraduate curriculum, selective admissions, enrollment management, advising, teaching evaluation and improvement, interdisciplinary instruction, support programs for at-risk students, and articulation with high schools.

Smale to Give Pitcher Lectures

The next series of Everett Pitcher Lectures will be held March 27, and 28, 1990 on the campus of Lehigh University in Bethlehem, Pennsylvania. They will be delivered by Professor Stephen Smale of the University of California at Berkeley. The title of his lectures is *Theory of Computation. Extending the Problem "P ≠ NP" to the Real and Complex Numbers*.

The lectures are open to the public and are held in honor of Everett Pitcher, former Secretary of the AMS, who served in the Mathematics Department at Lehigh from 1938 until 1978, retiring as Distinguished Professor of Mathematics. Further information can be obtained by writing Pitcher Lecture Series, Department of Mathematics, Lehigh University, Bethlehem, PA 18015, by calling: 215-758-3753.

News from the Mathematical Sciences Institute Cornell University

The first of two MSI summer workshops will be on the topic "Percolation Models of Material Failure," organized by S. Leigh Phoenix, Cornell University, the workshop will focus on probability models of material breakdown wherein the material

modeled as a network or lattice of elements, each of which may be present or absent with a certain probability, or have a randomly distributed strength, of fail in time according to a distribution which is a prescribed functional of the load history. A key feature is stress redistribution from failed to surviving elements, thus enhancing their rates of failure. Models of this sort, which have a close connection to the theory of percolation and particle systems, have been used to explain the breakdown and size effects in strength of diverse structures such as fibrous composites, dielectrics, superconducting networks, random fuse networks and general multiphase materials.

Workshop participants with diverse backgrounds will present talks on behavior of asymptotic distributions for strength and lifetime, scaling phenomena, critical points and transitions in global behavior, fractal behavior, localization, universality, renormalization, fracture toughness and interface effects among elements.

Invited speakers include: P. Beale, A. Chudnovski, H. Daniels, R. Durrett, P. Duxbury, J. Goddard, M. Grigoriu, G. Harlow, H. Herrmann, C. Hui, H. Kesten, P. Leath, J. McCoy, W. Newman, M. Ostoja-Starzewski, S. Redner, R. Smith, D. Srolovitz, H. Taylor, and Y. Termolina.

To register, contact MSI through Patricia Giordano at 201 Caldwell Hall, Cornell University, Ithaca, NY 14853-2602, 607-255-8005. For more information about the scientific content, contact S. Leigh Phoenix, Cornell University, Department of Theoretical and Applied Mechanics, 321 Thurston Hall, Ithaca, NY 14853, 607-255-3462 or 8818.

MSI is sponsoring a major symposium on "Modern Perspectives of Mathematics: Mathematics as a Consumer Good, Mathematics in Academia," March 29-31, 1990, at Cornell University. See this column in the November *Notices* and the dis-

play advertisement in the December and January issues for a full description. Registration packets are now available: Contact conference secretary Diana Drake at the same address and phone number listed above.

Research Experiences for Undergraduates Awards Announced

The Division of Mathematical Sciences of the National Science Foundation (NSF) has announced the 1990 awards in the Research Experiences for Undergraduates (REU) program. The program gives students hands-on experience in research in science, mathematics, and engineering. Designed to encourage talented students to pursue careers in research, REU gives the students a chance to experience the excitement of research while they are still in the process of making career choices.

The REU program makes two different kinds of awards: *Sites* and *Supplements*. REU Sites bring together groups of students during the summer for an organized program of research activities. The programs vary in size from six to twelve students and generally last seven or more weeks. REU Supplements permit a principal investigator to add an undergraduate student to his or her research grant.

Notices readers may wish to encourage talented undergraduates to seek information on participating in one of the REU Site programs. In addition to providing valuable and exciting experiences, the REU Sites also provide each student with a stipend.

This year, out of sixteen new proposals for REU Sites, there were nine new awards; there were also six continuing awards. The total DMS budget for the REU Sites is around \$0.5 million. What follows is a list of REU Sites planned for the summer of 1990, giving the names of the principal investigators, their institutions,

and the mathematical emphasis of each program.

STEVEN L. BLUMSACK, Florida State University, *Topics in applied and pure mathematics*; JAMES H. CURRY, University of Colorado, *Geometry of iterations and dynamical systems*; EDWARD CURTIS, University of Washington, *Problems in inverse conductivity*; JOSEPH A. GALLIAN, University of Minnesota, Duluth, *Graph theory and combinatorics*; PAUL R. GOODEY, University of Oklahoma, *Experimentation in group theory and dynamics*; APARNA W. HIGGINS, University of Dayton, *Algebraic graph theory*; DAVID L. HOUSMAN, Drew University, *Cooperative game theory*; LAWRENCE S. HUSCH, University of Tennessee, *Selected research topics*; REX K. KINCAID, College of William and Mary, *Matrix analysis and applications*; STEVEN G. KRANTZ, Washington University, *Harmonic analysis algorithms*; FRANK MORGAN, Williams College, *SMALL geometry project*; DONAL B. O'SHEA, Mount Holyoke College, *Selected computational activities*; ROBERT O. ROBSON, Oregon State University, *Experimental mathematical studies*; BRIGITTE SERVATIUS, Worcester Polytechnic Institute, *Discrete and applied mathematics*; GARY J. SHERMAN, Rose-Hulman Institute of Technology, *Computational group theory*.

The deadline to submit proposals for the 1991 REU Sites will likely be **October 10, 1990**. For more information, contact John V. Ryff, Program Director, Research Experiences for Undergraduates, Division of Mathematical Sciences, Room 339, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone: 202-357-3456; electronic mail: jryff@note.nsf.gov (Internet) or jryff@nsf (Bitnet).

Requests for REU Supplements may be submitted at any time. For more information, interested individuals should contact the DMS program director handling his or her research grant.

Visiting Scientist Positions at NSF

The Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF) expects to hire several "Visiting Scientists" as Program Directors for the fall of 1990. Mathematical scientists in all research areas will be considered.

These Visiting Scientists (also known informally as "rotators") hold one- or two-year appointments at the DMS while on leave from universities, colleges, industry, or national laboratories. The positions involve responsibility for the planning, coordination, and management of the DMS support for basic research activities. In addition to participation in the management of research grants and contracts, the positions involve budgeting and long-range planning for the DMS, travel to U.S. institutions through scientific site visits, and NSF outreach.

Applicants for these positions should have a Ph.D. or equivalent training in a field of the mathematical sciences, a broad knowledge of one of the active research areas of the DMS, several years of successful independent scientific research, some administrative experience, a knowledge of the general scientific community, skill in written communication techniques and preparation of technical reports, and the ability to communicate orally, including conducting briefings, site visits, workshops, and outreach.

The general duties and responsibilities of a Program Director are as follows:

- Plans, coordinates, and manages a program which supports basic and applied research that has an impact on major areas of the mathematical sciences; serves as recognized program authority in the DMS.
- Coordinates program budget and operating requirements to ensure that funds are appropriately allocated for the fulfillment of Program, Division, and Foundation goals and objectives.

- Designs and implements the proposal review and evaluation process for the Program to ensure quality of research proposals and appropriateness of review.

- Provides guidance and consultation on matters relating the Program to other NSF elements.

- Maintains liaison with other agencies and institutions within the mathematical sciences community and related disciplines to keep apprised of and to exchange information.

- Organizes and arranges committees and meetings to review current research activities, plan future research directions, and to initiate new research emphases, policies, and procedures.

The Division has taken pride in having one of the best staffs among all of the NSF divisions. The DMS and the Foundation provide extensive initial program management training. Further, professional training opportunities in personnel management, governmental process and relations, and science policy are available through the Foundation, and Program Directors are encouraged to participate.

Program Directors often interact with science managers in other science agencies and have the opportunity to represent the DMS through cross-directorate activities, international cooperative science activities, science education, and interdisciplinary research planning.

For information on Visiting Scientists' experiences in the DMS, see "Reflections of Departing DMS Rotators," *Notices*, September 1988, pp. 1007-1009.

The NSF is currently located in downtown Washington, DC, two blocks from the White House, a short walk from the Mall, and a block from George Washington University. Our national capital is noted as a beautiful international city of boulevards, parks, famous museums, fascinating history, good transportation, and outstanding restaurants and theatre. It is

close to the Appalachian mountains, the Chesapeake bay, and the Atlantic Ocean recreation areas.

For additional information, contact Judith S. Sunley, Director, Division of Mathematical Sciences, National Science Foundation, Washington, D.C. 20550; telephone: 202-355-9669.

Report on Funding Policy in Computer Science

A report on federal funding policy in computer science contains information that may be of interest to *Notices* readers, as it parallels some of the research funding policy issues that have been debated in the mathematical sciences community in recent years. The report, which will be released in late spring, was initiated by the Science Policy Committee of the Special Interest Group on Automata and Computability Theory (SIGACT) of the Association for Computing Machinery (ACM).

The report states that, although there are significant difficulties in categorizing basic and applied research, a number of general trends can be detected. For example, in academic computer science, support for basic research has declined relative to applied research, primarily because of increased emphasis in the military agencies on programs budgeted for applied research and development. According to the report, some in the field are concerned that this emphasis may distort the direction of the field and inhibit advances in its scientific foundations.

Entitled "A field in transition: Current trends and issues in academic computer science," the report is being written by Joel S. Yudken, Project Director, Project on Funding Policy in Computer Science, and Barbara Simons, vice-chair of SIGACT. Yudken is an NSF Fellow in Science, Technology, and Society at the Tremont Research Institute; Simons is a member of the research staff at the IBM Almaden Research Center. The project is sponsored by

SIGACT Science Policy Committee, together with a number of other organizations. The Association for Women in Mathematics and several other scientific organizations have also endorsed the project.

In addition to examining academic computer science funding, the report presents figures for overall federal funding of computer science research. For example, in the past twelve years, federal funding for computer science and engineering research grew faster than any other discipline; within the Department of Defense (DOD), funding of all computer science research grew approximately 250% in constant dollars between 1976 and 1988. In that same period, the percentage of DOD funding going to basic computer science research fell from 31% to 20%, reflecting the fact that the DOD is a relatively small supporter of basic research.

The report will compare the roles of other government agencies, such as the National Science Foundation and the National Aeronautics and Space Administration, in federal funding of computer science research. A breakdown by subfields will also be presented, as well as information about new funding initiatives.

The report will contain some of the most current data available on computer science funding. Copies of the report will be available from Funding Policy in Computer Science, P.O. Box 9896, Stanford, CA 94309-0210.

NSF Ends Support for Supercomputing Center

The National Science Foundation (NSF) has decided to terminate support for one of its five supercomputing centers, the John von Neumann Center (JvNC) in Princeton, New Jersey. Launched in 1985 as a consortium of thirteen universities, JvNC suffered a serious setback when ETA Systems, a subsidiary of Control Data Corporation and the maker of the processors used at the Center,

closed its doors last year. NSF funding for JvNC will be phased out by October of this year.

Originally, the NSF gave JvNC six months to prepare an alternative plan to using ETA products. The Center responded in time with a plan to replace their ETA supercomputers with a Cray Y-MP, but the NSF was not convinced the Center had sufficient support from its consortium members and turned down the \$70 million request for the next five years.

With an operating budget this year of \$12 million, the Center currently supports more than 1400 users around the country and has an in-house staff of 65. The NSF decision should not affect current users of the JvNC facilities, who can be absorbed by the other NSF centers. But it is likely that, without federal support, the Center will soon cease operation. JvNC officials are seeking financing from other federal, state, and private sources to keep the center going.

New T_EX Features from AMS

In response to calls from the mathematical sciences community, the Society has developed some new features and upgrades for T_EX products. This work was done as a service to the mathematical sciences community, as well as to the broader computer typesetting community, by making high-quality mathematical and technical typesetting more accessible, flexible, and powerful.

AMS-T_EX Version 2.0 and AMSFonts Version 2.0

Perhaps the main improvement the Society made was the development of Version 2.0 of the AMS-T_EX mathematical typesetting package. AMS-T_EX, created by Michael Spivak with the sponsorship of the AMS, consists of T_EX macros that facilitate the typesetting of complex mathematical formulas and displays. Version 2.0, prepared by Spivak and AMS staff members, incorporates a number of

improvements and changes suggested by users of AMS-T_EX. In the new version, many of the error messages and help messages are clearer, and many bugs that surfaced in special cases in using AMS-T_EX macros have now been eliminated. There have been refinements in some of the macros, and changes have been made to conserve memory space. In addition, access to fonts other than those defined in plain T_EX has been simplified. The AMS-T_EX macros have now been fully documented by Spivak in a separate file called AMS-T_EX.doc.

The AMS-T_EX preprint style file (AMSPPT.STY) has been rewritten to allow for many optional formatting features and thus provide users with greater flexibility. Among the new features are styles for chapters in books, in addition to journal articles, running heads, alternate page sizes, and tables of contents.

The AMSFonts package has been updated and expanded to include many fonts that users have requested. AMSFonts 2.0 includes

- the Euler fonts (Fraktur, 'Roman' cursive, and Script);
- a variety of Cyrillic fonts (lightface, bold, italic, caps and small caps, and sans serif), developed at the University of Washington;
- new point sizes of Computer Modern caps and small caps, and bold versions of the CM math italic and symbol fonts;
- two math symbol fonts, including a newly designed blackboard bold;
- an Euler compatible version of the Math extension font.

There will be two implementations of the new collection - one for PCs and mainframes, and one for use with Textures on the Macintosh. All the standard T_EX magnifications will be available for both implementations.

Users of the older versions of AMS-T_EX and AMSFonts can obtain the new versions from the AMS free of charge until September 1, 1990. The upgrade packages will include In-

stallation and User's Guides. Users should know that because of some changes in the way fonts are treated there is no cross-compatibility between \AA MS-TeX 2.0 and AMSFonts 2.0, and the older versions of both. You can use new with new, or old with old, but you cannot use any combination of new and old.

Those wishing to obtain upgrades of either \AA MS-TeX or AMSFonts should contact

Customer Services Department
American Mathematical Society
P.O. Box 6248
Providence, RI 02940
1-800-321-4AMS or
1-401-455-4000
CUST-SERV@MATH.AMS.COM

When requesting either upgrade, please specify either the PC or the Macintosh version. When requesting the PC version of the AMS-Fonts upgrade, please specify the resolution of the printer you will be using. The Macintosh versions will be supplied on double-sided, double-density 3.5" diskettes. Unless otherwise requested, the PC versions of the upgrades will be supplied on 5.25" high-density diskettes. If making a request by electronic mail, please provide a full postal address, as the \AA MS-TeX files and the AMS-Fonts collection will not be sent electronically.

$\text{\AA MS-TeX} / \text{L\AA T\AA EX}$ Style Files

In an effort to make \AA MS-TeX and L\AA T\AA EX more compatible, the Society has sponsored the development of several document styles for L\AA T\AA EX . The first is an \AA MS-TeX style option that allows L\AA T\AA EX users to use many of the \AA MS-TeX mathematical macros within existing L\AA T\AA EX docu-

ment styles (this is different from L\AA MS-TeX , a macro package Spivak is developing to incorporate some L\AA T\AA EX features into \AA MS-TeX). Two document styles, AMSBOOK and AMSART , use the \AA MS-TeX style option and provide formats suitable for a typical book, or for an article that might appear in either a journal or a collection. If an author uses one of these document styles to prepare a manuscript in L\AA T\AA EX , then that manuscript can be submitted electronically to any AMS publication, whereas only \AA MS-TeX electronic manuscripts were acceptable before. These files will be ready for distribution in late February.

Most TeX vendors have agreed to include the files which implement the \AA MS-TeX styles in L\AA T\AA EX packages they sell in the future, and to make this upgrade available to current L\AA T\AA EX users. In addition, the files will be available free of charge from the AMS and will reside in the public domain archives.

The \AA MS-TeX files for L\AA T\AA EX may be obtained in two ways. Users of electronic mail can receive the files electronically, by sending a request on Internet to:

$\text{AMS-L\AA T\AA EX@MATH.AMS.COM}$.
Users may also receive the files on IBM or Macintosh diskettes by contacting Rosanne Granatiero in the Publications Division, at the Society's address given above. Anyone requesting the \AA MS-TeX files for L\AA T\AA EX should specify whether they want to receive the files for a PC or a Macintosh.

Addendum to Newton's Principia, Read 300 Years Later

The following is an addendum to

the article *Newton's Principia, 300 Years Later*, by V. I. Arnold and V. A. Vasil'ev, that appeared in the November 1989 *Notices* 1148-1154.

Remark 3. At the Gibbs symposium at Yale (May 1989) some physicist informed the elder author that this duality law still holds in quantum mechanics.

Let $w(z)$ be any conformal mapping. Let $U(z) = |dw/dz|^2$ and $V = -|dz/dw|^2$. Then the mapping w transforms the trajectories of motion in the field of forces with potential U into the trajectories of the motion in the field with potential V .

Indeed, the Maupertuis integrals are essentially the same:

$$\sqrt{2(E-U)}|dz| = \sqrt{2(E'-V)}|dw|, \quad EE' = 1$$

Hence our duality is the duality between E and U in the expression $E - U$.

The quantum case is related to a similar identity for the quadratic forms in ψ :

$$\iint \left| \frac{\partial \psi}{\partial z} \right|^2 + (a + bU)|\psi|^2 dz d\bar{z} = \iint \left| \frac{\partial \psi}{\partial w} \right|^2 + (b - aV)|\psi|^2 dw d\bar{w}.$$

One of the particularly interesting cases is $w = e^z$. It shows that r^∞ is a "natural value" of r^∞ . Other interesting cases are $w = \sin z$, $w = \text{tg } z$, corresponding to $-|w^2 - 1|^{-1}$ and $V = -|1 + w^2|^{-1}$.

The quantum duality was discovered in 1953 by a Saigon mathematician, R. Faure. See R. Faure, *Transformations conformes en mécanique ondulatoire*, C.R.A.S. Paris, t. 271, pp. 603-605, Séance du 21 septembre 1953.

Funding Information for the Mathematical Sciences

NSF Expands Curriculum Development

The National Science Foundation (NSF) has announced an expanded program to support major changes to reshape and strengthen undergraduate courses, curricula, and laboratories in engineering, mathematics, and the sciences. The program is similar in spirit and purpose to the NSF's program on calculus curriculum development, but addresses courses in all areas. This year, the program will emphasize proposals affecting introductory-level courses.

The principal goal of the program is to support fresh approaches and experiments to produce major changes in U.S. undergraduate education. Entitled Undergraduate Curriculum and Course Development in Engineering, Mathematics, and the Sciences, the program will support projects in all fields normally supported by the Foundation. Multidisciplinary and interdisciplinary proposals are especially encouraged.

For mathematics, the primary focus is on proposals dealing with non-calculus, introductory courses such as precalculus, discrete mathematics, geometry, and statistics. Similarly, proposals that would include elements of calculus in broad courses aimed at mathematical literacy or in interdisciplinary courses would be appropriate for this program. Proposers interested in calculus and related courses, such as the differential equations and linear algebra courses typically included in the two-year calculus sequence, should submit to

the Undergraduate Curriculum Development in Mathematics: Calculus Program.

Proposals will be accepted for two categories: Comprehensive Development Projects, and Prototype and Pilot Projects. Proposals submitted under the first category should describe a well-defined vision and well-formulated plans for comprehensive introductory-level curriculum development. The NSF anticipates supporting a few major projects that involve a broad-based, cohesive set of activities to significantly change undergraduate education at the introductory level.

Proposals submitted under the second category should present more focused activities as typified by individual courses, laboratories and topic areas at the introductory level. Also appropriate under this category are proposals for activities such as workshops, studies, or pilot projects to improve the probability for success of a future comprehensive project. The NSF expects to support a modest number of projects having the potential to produce significant improvements in the undergraduate learning experience.

The closing date for proposals in both categories is **April 9, 1990**; awards are expected to be made in the fall of 1990. Projects may request support for a period of up to five years. The number of awards in each category will depend on the quality of proposals received and the availability of funds for this program.

The program announcement (publication number NSF 89-125), with more detailed information and the forms to be included in a proposal, is available from Forms and Publications Unit, Room 232, National Science Foundation, 1800 G Street NW, Washington DC 20550; telephone 202-357-7668; electronic mail: pubs@note.nsf.gov (Internet) or pubs@nsf (Bitnet).

Further information is available from Spud Bradley, director of the calculus curriculum development program, at: National Science Foundation, Room 639, 1800 G Street NW, Washington, DC 20550; telephone: 202-357-7051; electronic mail: sbradley@note.nsf.gov (Internet) or sbradley@nsf (Bitnet). Another contact is Deborah Lockhart, program director for Special Projects in the Division of Mathematical Sciences, at: National Science Foundation, Room 339, 1800 G Street NW, Washington, DC 20550; telephone: 202-357-3453; electronic mail: dlockhar@note.nsf.gov (Internet) or dlockhar@nsf (Bitnet).

1991-1992 Fulbright Competition Opens

The Council for International Exchange of Scholars has opened the competition for Fulbright grants in research and university lecturing abroad during the 1991-1992 academic year.

Approximately 1000 grants will be awarded for periods ranging from three months to a full academic year. There are openings in over 100 coun-

tries, and, in many regions, there is opportunity for multi-country research. Fulbright awards are made in virtually all disciplines and all academic ranks. Applications are encouraged from retired faculty and independent scholars.

Grant benefits, which vary by country, generally include round-trip travel for the grantee and, for most full-academic year awards, one dependent; stipend in U.S. dollars and/or local currency; tuition allowance for school-age children in many countries; and book and baggage allowances.

The basic eligibility requirements are: U.S. citizenship; Ph.D. or comparable professional qualifications; university or college teaching experience; and, for selected assignments, proficiency in a foreign language. There is no limit on the number of Fulbright grants a single scholar may receive, but there must be a three-year interval between awards.

Application deadlines for the awards are:

June 15, 1990. Australasia, India, U.S.S.R., and Latin America, except Mexico, Venezuela, and the Caribbean.

August 1, 1990. Africa, Asia, Western Europe, Eastern Europe, the Middle East, and lecturing awards to Mexico, Venezuela, and the Caribbean; travel-only awards to France, Italy, and Federal Republic of Germany.

November 1, 1990. Institutional proposals for the Scholar-in-Residence Program; and International Education Administrators Program in Federal Republic of Germany, United Kingdom, and Japan.

January 1, 1990. NATO Research Fellowships and Spain Research Fellowships.

Application materials will be available in March. For more information and applications, contact: Council for International Exchange of Scholars, 3400 International Drive, Suite M-500, Washington, DC 20008-3097; telephone: 202-686-7866.

Deadlines for NSF International Programs

The National Science Foundation sponsors a number of programs to facilitate international collaborations among researchers in science, mathematics, and engineering. Some of these programs have deadlines or target dates in the spring of 1990 (in programs with target dates, it is preferable to submit proposals by that date, but they may be submitted at any time).

These programs are listed below, together with brief descriptions, deadlines or target dates, and a contact person. All telephone numbers are in the 202 area code. The mailing address is Division of International Programs, National Science Foundation, 1800 G Street NW, Washington, DC 20550.

Long-term Research Opportunities in Japan. Visits for U.S. researchers at Japanese government, university and industrial laboratories for six to 24 months; target date March 1; Myra McAuliffe, 357-9558.

Cooperative Science Activities. Cooperative science, engineering, and science education programs with Austria, Denmark, the Netherlands, Norway, Finland, Sweden, the United Kingdom, the Federal Republic of Germany, and Switzerland; deadline March 1; Christine French or Christine Glenday, 357-9700.

U.S.-India Cooperative Science. Joint workshops and seminars, and individual travel; deadline March 1; Osman Shinaishin, 357-9402.

Science in Developing Countries. Visits, research participation, seminars, and dissertation improvement; target date March 1. For North Africa and Turkey: Ed Field, 357-9402; East Asia and Sub-Saharan Africa: Gerald Edwards, 357-9537; South and West Asia: Osman Shinaishin, 357-9402; Latin America and the Caribbean: Harold Stolberg and David Kelland, 357-7421.

State-of-the-art Survey Teams. Support for expert reviews of specific disciplinary and interdisciplinary areas,

especially those most promising U.S. researchers' participation; target date March 1; Charles Owens, 357-9632.

U.S.-Australia Cooperative Science Program. Proposals for joint research seminars, and visits; deadline April 1; Carole Ganz, 357-9700.

U.S.-People's Republic of China Cooperative Science. Cooperative research only, no travel requests; unsolicited proposals for joint seminars and workshops; target date April 1; Alice Hogan or William Y. Chang, 357-7393, or Russell Sweet, 357-9824.

U.S.-Yugoslavia Joint Board for Scientific and Technological Cooperation. Joint research, bilateral workshops, and project development; target date April 1; Rose Bate, 357-7393.

U.S.-Eastern Europe Cooperative Science. Cooperative research projects or bilateral seminars in Bulgaria, Czechoslovakia, Hungary, Poland, and Romania; target date May 1; Gerson Sher, 357-7494.

U.S.-France Cooperative Science. Cooperative research projects or joint workshops and seminars; deadline May 1; Christine Glenday, 357-7554.

U.S.-Italy Cooperative Science. Cooperative research projects, joint seminars and workshops; target date May 1; Harold Stolberg, 357-7421.

U.S.-Latin America Cooperative Science Programs. Cooperative research (partial support), bilateral workshops, and scientific visits. Foreign collaborator must submit a parallel proposal to a counterpart agency; deadline May 1. For Argentina and Brazil: David Kelland, 357-9564; for Mexico and Venezuela: Harold Stolberg and Kelland, 357-7421.

U.S.-Japan Cooperative Science Program. Cooperative research or joint seminar activities; May 1; Myra McAuliffe, 357-9558.

Research Fellowships in India. The Council for International Exchange of Scholars has announced

the availability of twelve long-term (6-10 months) and nine short-term (2-3 months) awards for research in India during 1991-1992. These grants are available in all academic disciplines except clinical medicine.

The purpose of the program is to open new channels of communication between academic and professional groups in the U.S. and India and to encourage a wider range of research activity between the two countries than currently exists. Scholars and professionals with limited or no prior experience in India are especially encouraged to apply.

Applicants must be U.S. citizens at the postdoctoral or equivalent level. The terms of the fellowships include \$1500 per month, of which \$350 per month is payable in dollars and the balance in rupees, and an allowance for books, study and travel in India, and international travel for the grantee. Longterm grantees receive additional allowances, including funds for dependents.

The program is sponsored by the Indo-U.S. Subcommission on Education and Culture and is funded by the United States Information Agency, the National Science Foundation, the Smithsonian Institution, and the Government of India. The application deadline is **June 15, 1990**. Application forms and further information are available from: Council for International Exchange of Scholars, Attn: Indo-American Fellowship Program, 3400 International Drive, Suite M-500, Washington, DC 20008-3097; telephone: 202-686-4013.

Mittag-Leffler Institute 1990-1991 Grants

The Mittag-Leffler Institute announces a number of grants for the year 1990-1991. The program of the institute

starts on September 1 and ends on May 31. The grants are intended for recent Ph.D.'s or advanced graduate students and amount to 8,500 Swedish crowns per month, or 85,000 for those who attend for the duration of the program. Housing on the premises of the institute can be offered to some of the participants.

The subject for 1990-1991 is *Operator theory and complex analysis*.

Several aspects of the field will be treated, such as

- Hankel operators
- Toeplitz operator
- Model operator
- Paracommutators
- Wavelets
- Hilbert and other spaces of analytic functions
- Reproducing kernels
- Quantization
- Operator calculi
- Clifford analysis

The following experts in the field have already agreed to take part in the program for an extended period:

Milne Anderson, Jonathan Arazy, Sheldon Axler, Jacob Burbea, Lewin Coburn, Mischa Cotlar, Hans Fichtinger, Stephen Fisher, Karlheinz Gröchenig, Sergei Khrushchev, Dmitry Khavinson, Bernd Kirstein, Chun Li, Alan McIntosh, Gadadhar Misra, Nikolai Nikolskii, Thierry Paul, A. A. Pekarskii, V. V. Peller, Tao Qian, Richard Rochberg, Cora Sadosky, Richard Timoney, Dan Timotin, Harald Upmeyer, Kehe Zhu.

The following Scandinavians also plan to stay at the institute during some period:

Björn Jawerth, Henrik Martens, Lassi Päiväranta, Peter Sjögren, Jan-Olov Strömberg.

Application forms can be obtained from the institute and should be returned to: The Board of the

Mittag-Leffler Institute, Auravägen 17, S-182 62 Djursholm, Sweden, before **March 31, 1990**. Telephone (46) 80-755 1809.

Improving Research at Minority Institutions

The National Science Foundation sponsors a program to improve the research capabilities of academic institutions with substantial minority enrollments. Entitled Research Improvement at Minority Institutions, the program supports faculty research and student participation, research equipment acquisition, and cooperative research between industry and academia. The program is also designed to enhance the ability of historically black colleges and universities to participate in federally-sponsored programs.

For an institution to be eligible, more than 50% of its student body must be Black, Hispanic, American Indian, Alaskan Native, or Native Pacific Islander, or 20% of any one of these underrepresented minority groups. In addition, institutions must offer engineering programs or graduate programs in science.

In fiscal year 1990, there were two awards in the mathematical sciences, out of a total of fifteen awards (for brief descriptions of the projects, see *Notices*, January 1990, page 27). The deadline for proposals for the next round of awards is **March 1, 1990**.

For more information, contact Roosevelt Calbert, Program Director, Research Improvement at Minority Institutions, Division of Research Initiation and Improvement, National Science Foundation, 1800 G Street NW, Washington, DC 20550; telephone: 202-357-7350; electronic mail: rcalbert@nsf.

Manhattan, Kansas

Kansas State University

March 16–17

The eight-hundred-and-fifty-fifth meeting of the American Mathematical Society will be held at Kansas State University in Manhattan, Kansas on Friday, March 16, and Saturday, March 17, 1990.

Invited Addresses

By invitation of the Central Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks, and the scheduled times of presentation are:

J. BRIAN CONREY, Oklahoma State University, Stillwater, *Modular forms and the Riemann zeta-function*, 11:00 a.m. Friday.

STEWART B. PRIDY, Northwestern University, *Representation theory and stable homotopy of finite groups*, 1:30 p.m. Friday.

JEAN-PIERRE ROSAY, University of Wisconsin, Madison, *Examples of Cauchy-Riemann structures*, 11:00 a.m. Saturday.

JANG-MEI WU, University of Illinois at Urbana-Champaign, *Harmonic measure and applications*, 1:30 p.m. Saturday.

Special Sessions

By invitation of the same committee, there will be eleven special sessions of selected twenty-minute papers. The topics, the names and affiliations of the organizers, and the speakers are as follows:

Harmonic analysis and probability theory, ANDREW G. BENNETT, Kansas State University. Nakhle Asmar, Rodrigo Bañuelos, William Beckner, Andrew G. Bennett, Eric A. Carlen, J.-A. Chao, Michael Cranston, Burgess Davis, Uwe Einmahl, Richard Holley, Pei Hsu, Roger L. Jones, Michael Lacey, Charles Moore, Carl Mueller, Joseph Rosenblatt, Kenneth A. Ross, Anton Thalmaier, and Gang Wang.

Orthostructures, DAVID J. FOULIS, University of Massachusetts at Amherst, and RICHARD J. GREECHIE, Kansas State University. Larry Cammack, Tae Ho Choe, Gary D. Crown, David J. Foulis, Andrew S. Golfin, Jr.,

Richard Greechie, Stanley Gudder, John R. Harbort, Matthias P. Kläy, William David Miller, Robert Pizotti, Gottfried T. Rüttimann, Christian Schindler, George Schrag, Otmar Spinas, Alexander Wilce, and Matthew Younce.

Numerical analysis, KADOSA M. HALASI and Q. ZOU, Kansas State University. John H. Bolstad, Chun-Lung Chang, Shiyi Chen, Thomas K. DeLillo, Douglas Greenspan, Karl Gustafson, Yue-Kuen Kwok, Steve Parnell, Chi-Wang Shu, John Strikwerda, C. H. Su, Abdul J. Tamraz, and Greta Tryggvason.

Geometric function theory, DAVID H. HAMILTON, University of Maryland, College Park, and JOHN F. ROBERTS, Virginia Polytech Institute and State University. Karl Barth, Tom Carroll, David Drasin, P. L. Duren, Gary Gundersen, David H. Hamilton, Juha Heinonen, David A. Herron, A. Hinkkanen, Dmitry Khavinson, Boris Krenblum, Y. J. Leung, John Lewis, Juan Manfredi, Jean McKemie, David Minda, Richard Rochberg, David Shea, Li-Chien Shen, Wayne Smith, Susan G. Stapledon, David A. Stegenga, Kenneth Stephenson, Carl Sundberg, and Enrique Villamor.

Partial differential equations, LIGE LI, Kansas State University. Nicholas D. Alikakos, Robert Cantrell, Chris Cosner, Allan Edelson, Alan Elcrantz, Robert Gardner, Jerome A. Goldstein, Karl Gustafson, Nela Lakoš, Anthony Leung, Chin-Yuan Lin, Ronghui Lui, Gisele Ruiz Rieder, Renate Schaaf, Andreas Stein, Izumi Takagi, and Horst R. Thieme.

Commutative algebra, SATYAGOPOL MANDAL, University of Kansas. Ian M. Aberbach, Shreeram S. Bhargava, D. D. Anderson, Sankar Prasad Dutta, Benjamin Johnston, Jee Koh, Gennady Lyubeznik, Thomas Marberg, T. T. Moh, M. P. Murthy, Budh Nashier, A. Prabhakar, Rao, Christel Rotthaus, Avinash Sathaye, Hema Sathyanarayanan, Bernd Ulrich, Jugal Verma, Dana T. West, Roger Wiegand, Sylvia Wiegand, and David Wright.

Inverse problems and scattering theory, ALEXANDER G. RAMM, Kansas State University. Carlos Berenstein, Y. M. Chen, Mikhail V. Klivanov, Joyce R. McLaughlin, Reese T. Prosser, A. G. Ramm, William Rundell, E. Sacks, and Ziqi Sun.

Ergodic theory, JOSEPH M. ROSENBLATT, Ohio State University. Idris Assani, Alexandra Bellow, Vitaly Bergelson, Christopher Bose, R. E. Bradley, Dogan Comez, Alan Forrest, Roger L. Jones, I. Kornfeld, James H. Olsen, Karl Petersen, M. B. Rao, Karin Reinhold-Larsson, Daniel J. Rudolph, Laszlo I. Szabo, M. Wierdl, and Andrés del Junco.

Graph theory, RICHARD H. SCHELP, Memphis State University. Lowell W. Beineke, Gary Chartrand, Fan R. K. Chung, R. C. Entringer, Paul Erdős, R. J. Faudree, R. L. Graham, Kathryn F. Jones, J. Richard Lundgren, Bennet Manvel, Saul Stahl, L. A. Székely, W. T. Trotter, John Watkins, and Robin J. Wilson.

Groups and geometries, ERNEST E. SHULT, Kansas State University. Michael Aschbacher, Curtis Bennett, Hans Cuyper, Daniel Frohardt, George Glauberman, Jonathan I. Hall, Diane Herrmann, Chat Yin Ho, Norman L. Johnson, Peter M. Johnson, Spyros S. Magliveras, Geoffrey Mason, Ulrich Meierfrankenfeld, Stanley E. Payne, Stephen D. Smith, H. Voelklein, Richard Weiss, and Satoshi Yoshiara.

Applications of category theory, GEORGE E. STRECKER, Kansas State University. H. L. Bentley, Gabriele Castellini, Eraldo Giuli, Jurgen Koslowski, Harriet M. Lord, Saunders Mac Lane, Ernest G. Manes, Michael W. Mislove, L. D. Nel, Frank J. Oles, Robert Pare, Guenther E. Richter, Helmut Rohrl, Sergio Salbany, David A. Schmidt, Friedhelm Schwarz, Walter Tholen, and Sibylle Weck-Schwarz.

Abstracts for consideration for these sessions should have been submitted by the **November 21, 1989** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Late papers will not be accommodated.

Registration

The registration desk will be located inside the main entrance to Cardwell Hall, and will be open from 8:00 a.m. to 5:00 p.m. on Friday, March 16, and on Saturday, March 17, from 8:00 a.m. to noon. The registration fees are \$30 for members of the AMS, \$45 for nonmembers, and \$10 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

Accommodations

All accommodations have restaurants in or adjacent to them. Aggieville, on the edge of the campus, offers a wide variety of fast food and full service restaurants. On campus the K-State Union Stateroom will be open for breakfast and lunch. Information on area restaurants will be included in a welcome packet available at the meeting registration desk. The AMS is not responsible for rate changes or accommodations offered by hotels/motels.

All Seasons Motel

1501 Tuttle Creek Bld, Manhattan, KS 66506
Telephone: 913-539-5391

Single \$35.44 Double \$39.87

Continental Inn

100 Bluemont Ave., Manhattan, KS 66506
Telephone: 913 776-4771

1 person/1 bed \$35.28 1 person/2 beds \$37.38
2 persons/1 bed \$39.68 2 persons/2 beds \$44.10

Holiday Inn/Holidome

530 Richards Drive, Manhattan, KS 66506
Telephone: 913-539-5311

Single \$64.24 Poolside Single/Double \$70.88

Motel 6

510 Tuttle Creek, Manhattan, KS 66506
Telephone: 913-537-1022

Single \$21.95 Double \$28.61

University Inn

17th & Anderson Avenue, Manhattan, KS 66506
Telephone: 913-539-7531

Single \$38 Double \$44
These are special rates offered to participants.

Super 8

200 Tuttle Creek, Manhattan, KS 66506
Telephone: 913-527-8468

1 person/1 bed \$31.26 2 persons/1 bed \$35.59
2 persons/2 beds \$37.76

Travel

Kansas State University is located in Manhattan, eight miles north of Interstate 70, and one-hundred-and-thirty miles west of Kansas City. Flights are available to Kansas City International Airport in Kansas City, Missouri, on several major airlines with connections to the Manhattan Municipal Airport. Airport shuttle service is available to the campus at reasonable rates.

If traveling by car, participants should take Interstate 435 (south) and follow Interstate 70 (west) to State Highway 177 into Manhattan.

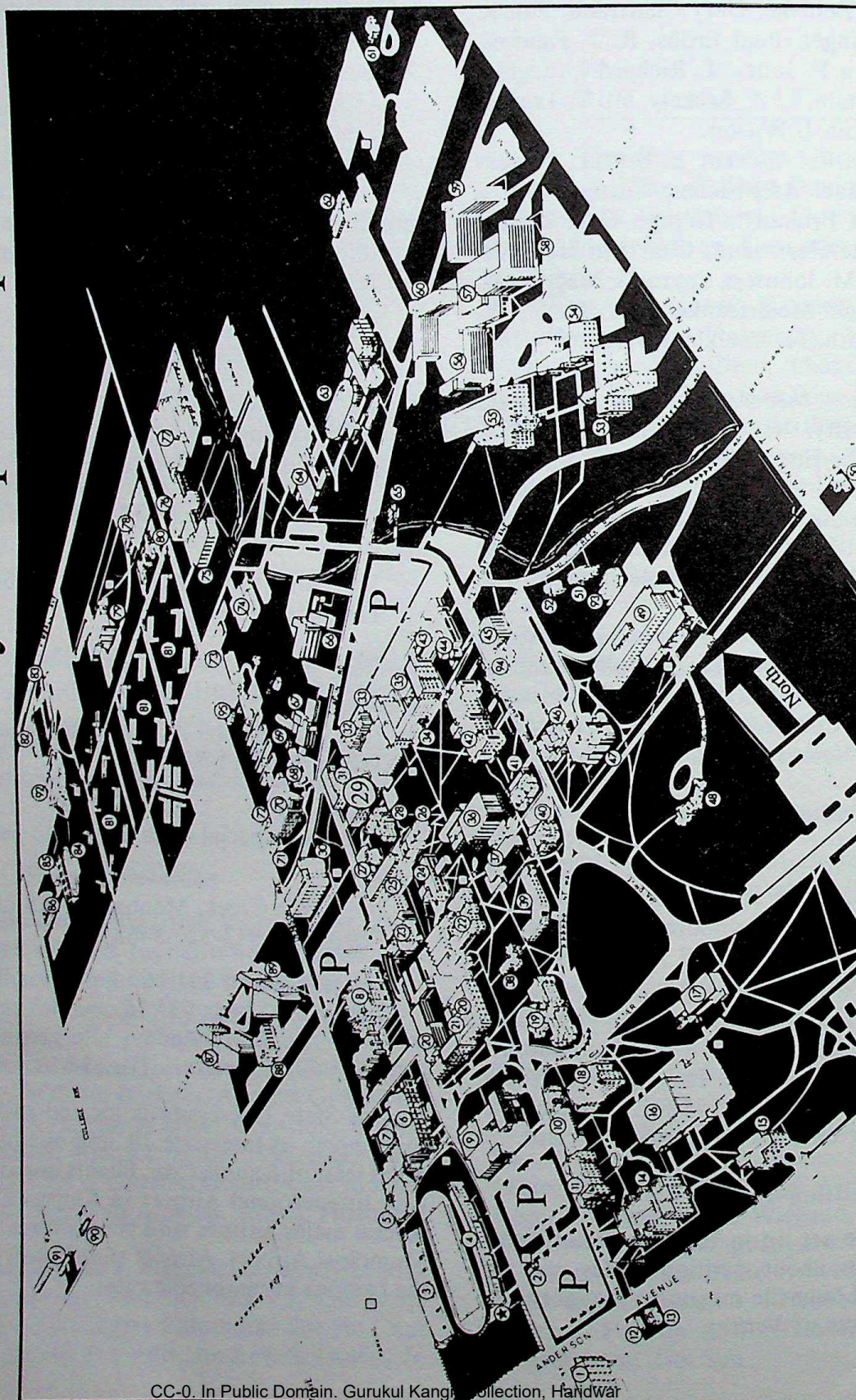
Parking

Parking is available on campus. A parking fee of \$2 will be charged on Friday, March 16.

Weather

A wide range of weather is possible in Kansas in March. Participants are advised to note regional forecasts at the time of the meeting.

Kansas State University Campus Map



Parking — P

Cardwell Hall (29)

Program of the Sessions

The time limit for each contributed paper in the sessions is ten minutes. In the special sessions, the time limit varies from session to session and within sessions. To maintain the schedule, time limits will be strictly enforced.

Abstracts of papers presented in the sessions at this meeting will be found in the March 1990 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.

Friday, March 16

Special Session on Geometric Function Theory, I

8:30 a.m. - 10:50 a.m. Room 144, Cardwell Hall

- 8:30 a.m. *The maximum modulus and characteristic.*
(1) **David Drasin**, Purdue University, West Lafayette (855-30-200)
- 9:00 a.m. *Estimates for sets where a meromorphic function is large.*
(2) **Matts Essen**, Uppsala University, Sweden, **John Rossi**, Virginia Polytechnic Institute and State University, and **Daniel Shea***, University of Wisconsin, Madison (855-30-193)
- 9:30 a.m. *An application of the spread relation to algebraic differential equations.*
(3) **Gary G. Gundersen**, University of New Orleans (855-34-138)
- 10:00 a.m. *On an L^2 inequality involving entire functions of exponential type.*
(4) **Li-Chien Shen**, University of Florida (855-30-137) (Sponsored by Kermit N. Sigmon)
- 10:30 a.m. *Stochastic Loewner equation. Preliminary report.*
(5) **David Rochberg** and **Richard Rochberg***, Washington University (855-30-139)

Special Session on Inverse Problems and Scattering Theory, I

8:30 a.m. - 10:50 a.m. Room 143, Cardwell Hall

- 8:30 a.m. *Efficient numerical methods for solving inverse problems of PDE.*
(6) **Y. M. Chen**, State University of New York, Stony Brook (855-65-02) (Sponsored by Ram P. Srivastav)
- 9:20 a.m. *Recovery of coefficients in first order hyperbolic equations.*
(7) **Michael Pilant** and **William Rundell***, Texas A & M University, College Station (855-35-73)

- 10:10 a.m. *An iterative method for one-dimensional second order inverse spectral problems. Preliminary report.*
(8) **William Rundell**, Texas A & M University, College Station, and **Paul E. Sacks***, Iowa State University (855-35-72)

Special Session on Harmonic Analysis and Probability Theory, I

9:00 a.m. - 10:50 a.m. Room 131, Cardwell Hall

- 9:00 a.m. *Martingale transforms and paraproducts.*
(9) **J.-A. Chao***, Cleveland State University, and **R.-L. Long**, Academia Sinica, People's Republic of China (855-60-51)
- 9:30 a.m. *Conformal geometry, Sobolev inequalities and symmetrization. Preliminary report.*
(10) **William Beckner**, University of Texas, Austin (855-42-69)
- 10:00 a.m. *Fractional integration on tail σ -fields.*
(11) **Andrew G. Bennett**, Kansas State University (855-60-109)
- 10:30 a.m. *Superadditivity of Fisher's information and logarithmic Sobolev inequalities.*
(12) **Eric A. Carlen**, Princeton University (855-62-170)

Special Session on Orthostructures, I

9:00 a.m. - 10:50 a.m. Room 121, Cardwell Hall

- 9:00 a.m. *Sheaf representation theorem for Baer and Rickart rings.*
(13) **Douglas G. Burkholder** and **Gary D. Crown***, Wichita State University (855-16-161)
- 9:30 a.m. *Graph theoretic properties in the context of orthomodular theory. Preliminary report.*
(14) **Gerald Schrag*** and **Larry Cammack**, Central Missouri State University (855-06-185)
- 10:00 a.m. *On states and generalized state spaces of the generalizations of the Greechie lattice. Preliminary report.*
(15) **Larry Cammack*** and **Gerald Schrag**, Central Missouri State University (855-06-187)

Friday, March 16 (cont'd)

- 10:30 a.m. *Computational systems for research on*
(16) *orthostructures*. Preliminary report.
William David Miller, Oklahoma State University,
Stillwater (855-68-196)

Special Session on Partial Differential Equations, I

9:00 a.m.–10:50 a.m. Room 129, Cardwell Hall

- 9:00 a.m. *Least-energy solutions to a semilinear Neumann*
(17) *problem related to biological pattern formation*.
Izumi Takagi, Tohoku University, Japan (855-35-188)
- 9:30 a.m. *Spatially degenerate nonlinear diffusion with drift and*
(18) *the Wentzel boundary condition*. Preliminary report.
Jerome A. Goldstein*, Tulane University, and
Chin-Yuan Lin, Texas A & M University, College
Station (855-35-118)
- 10:00 a.m. *Stability and Hopf bifurcation of solutions of the*
(19) *Dirichlet problem for diffusive predator-prey systems*.
Preliminary report.
Robert Gardner, University of Massachusetts,
Amherst (855-35-43)
- 10:30 a.m. *A quasilinear parabolic problem in one space*
(20) *dimension*.
J. R. Dorroh and **Gisele Ruiz Rieder***, Louisiana
State University, Baton Rouge (855-35-191)

Special Session on Commutative Algebra, I

9:00 a.m.–10:50 a.m. Room 102, Cardwell Hall

- 9:00 a.m. *Galois theory on the line*.
(21) **Shreeram S. Abhyankar**, Purdue University, West
Lafayette (855-14-07)
- 9:30 a.m. *Finite generation of monoids of fractional ideals*.
(22) Preliminary report.
D. D. Anderson, University of Iowa (855-13-12)
- 10:00 a.m. *Intersection multiplicity of modules*.
(23) **Sankar Prasad Dutta**, University of Illinois,
Urbana-Champaign (855-13-146)
- 10:30 a.m. *Finite phantom projective dimension*. Preliminary
(24) report.
Ian M. Aberbach, University of Michigan, Ann Arbor
(855-13-95)

Special Session on Ergodic Theory, I

9:00 a.m.–10:50 a.m. Room 130, Cardwell Hall

- 9:00 a.m. *Ergodic theorems for subsequences and moving*
(25) *averages*. Preliminary report.
Roger L. Jones, DePaul University (855-42-74)

- 9:30 a.m. *A maximal inequality and its consequences in ergodic*
(26) *theory*.
J. Rosenblatt and **M. Wierdl***, Ohio State University,
Columbus (855-28-179)

- 10:00 a.m. *On induced operators*.
(27) **R. E. Bradley**, Northwestern University (855-28-37)
- 10:30 a.m. *Failure of the Wiener-Wintner property for the helical*
(28) *transform in L^1* . Preliminary report.
Idris Assani, University of North Carolina, Chapel Hill
(855-28-39)

Special Session on Graph Theory, I

9:00 a.m.–10:50 a.m. Room 146, Cardwell Hall

- 9:00 a.m. *Coloring tournaments*.
(29) **Kunwarjit S. Bagga**, Ball State University, **Lowell W. Beineke***, Indiana University-Purdue University, Ft.
Wayne, and **Frank Harary**, New Mexico State
University, Las Cruces (855-05-114)
- 9:30 a.m. *A combinatorial approach to the integral*
(30) *multicommodity flow problem with application to the*
packed routing. Preliminary report.
F. Shahrokhi, North Texas University, and **L. A. Székely***, University of New Mexico (855-05-48)
(Sponsored by Richard H. Schelp)
- 10:00 a.m. *k-graphs with uniformly distributed subgraphs*.
(31) Preliminary report.
F. R. K. Chung, Bell Communications Research,
Morristown, NJ, and **R. L. Graham***, AT&T Bell
Laboratories, Murray Hill, New Jersey (855-05-87)
- 10:30 a.m. *Quasi-random classes of hypergraphs*.
(32) **Fan R. K. Chung**, Bellcore, Morristown, New Jersey
(855-05-113)

Special Session on Groups and Geometries, I

9:00 a.m.–10:50 a.m. Room 145, Cardwell Hall

- 9:00 a.m. *Extending morphisms of groups and graphs*.
(33) **Michael Aschbacher***, California Institute of
Technology, and **Yoav Segev**, Ben Gurion University
Israel (855-20-152)
- 9:30 a.m. *A Cayley integer approach to the Leech lattice*.
(34) Preliminary report.
George Glauberman, University of Chicago
(855-20-49)
- 10:00 a.m. *Applications of algebraic curves to the representation*
(35) *theory of SL_2* . Preliminary report.
Geoffrey Mason, University of California, Santa Cruz
(855-20-18)
- 10:30 a.m. *Sharply transitive linear groups over algebraically*
(36) *closed fields*.
G. Cherlin, Rutgers University, New Brunswick, T.
Grundhöfer, University Tübingen, Federal Republic
Germany, **A. Nesin**, University of California, Irvine,
and **H. Voelklein***, University of Florida (855-20-40)

Special Session on Applications of Category Theory, I

9:00 a.m.–10:50 a.m. Room 103, Cardwell Hall

- 9:00 a.m. *Category-sorted algebra and its applications.*
(37) **David A. Schmidt**, Kansas State University (855-18-96) (Sponsored by George E. Strecker)
- 9:30 a.m. *Compact pairs and generalized perfect maps.*
(38) **Eraldo Giuli**, Università degli Studi di L'Aquila, Italy (855-18-31) (Sponsored by George E. Strecker)
- 10:00 a.m. *Groups of dualities. Preliminary report.*
(39) **Georgi D. Dimov**, Bulgarian Academy of Sciences, Bulgaria, and **Walter Tholen***, York University (855-18-29)
- 10:30 a.m. *Internal description of hulls.*
(40) **Friedhelm Schwarz** and **Sibylle Weck-Schwarz***, University of Toledo (855-18-86)

Session on Algebra

9:00 a.m.–10:30 a.m. Room 120, Cardwell Hall

- 9:00 a.m. *Rings of integer-valued polynomials over semi-local PID's.*
(41) **Jim Brewer*** and **Lee Klingler**, Florida Atlantic University (855-13-52)
- 9:20 a.m. *The Picard group for the commutative ring theorist.*
(42) Preliminary report.
F. W. Call*, University of Michigan, Ann Arbor, and **R. Heitmann**, University of Texas, Austin (855-13-24)
- 9:40 a.m. *Gröbner bases and automorphisms of polynomial ring.*
(43) Preliminary report.
Wei Li, Purdue University, West Lafayette (855-13-08)
- 10:00 a.m. *Infinitesimal extensions of glued varieties.*
(44) **Khomo T. S. Mohapeloa**, Pennsylvania State University, McKeesport, PA (855-14-183)
- 10:20 a.m. *On an extremal problem in the Bloch space.*
(45) **Flavia Colonna**, George Mason University (855-30-89)

Invited Address

11:00 a.m.–noon Room 101, Cardwell Hall

- (46) *Modular forms and the Riemann zeta-function.*
J. Brian Conrey, Oklahoma State University (855-11-173)

Invited Address

1:30 p.m.–2:30 p.m. Room 101, Cardwell Hall

- (47) *Representation theory and stable homotopy of finite groups.*
Stewart B. Priddy, Northwestern University (855-55-184)

Special Session on Harmonic Analysis and Probability Theory, II

3:00 p.m.–5:50 p.m. Room 131, Cardwell Hall

- 3:00 p.m. *Intrinsic ultracontractivity and eigenfunction estimates for the Schrödinger operators. Preliminary report.*
(48) **Rodrigo Bañuelos**, Purdue University, West Lafayette (855-31-36)
- 3:30 p.m. *Distribution function inequalities for the density of the area integral.*
(49) **Rodrigo Bañuelos** and **Charles Moore***, Purdue University, West Lafayette (855-31-141)
- 4:00 p.m. *On the almost sure behavior of sums of iid random variables in Hilbert space.*
(50) **Uwe Einmahl**, Indiana University, Bloomington (855-60-68) (Sponsored by James D. Kuelbs)
- 4:30 p.m. *On weak convergence in dynamical systems to self-similar processes.*
(51) **Michael Lacey**, Indiana University, Bloomington (855-60-54)
- 5:00 p.m. *Ergodic averages on spheres. Preliminary report.*
(52) **Roger L. Jones**, DePaul University (855-42-70)
- 5:30 p.m. *Almost everywhere convergence of convolution powers.*
(53) **A. Bellow**, Northwestern University, **R. Jones**, DePaul University, and **Joseph Rosenblatt***, Ohio State University, Columbus (855-60-157)

Special Session on Orthostructures, II

3:00 p.m.–5:20 p.m. Room 121, Cardwell Hall

- 3:00 p.m. *Filters in orthoalgebras and their relationship to supports in test spaces.*
(54) **Andrew S. Gelfin, Jr.**, Gettysburg College (855-06-163)
- 3:30 p.m. *Coupled entities. Preliminary report.*
(55) **David J. Foulis**, University of Massachusetts, Amherst (855-81-162)
- 4:00 p.m. *Refinement and unique Mackey decomposition for manuals and orthoalgebras.*
(56) **Matthew B. Younce**, Rhode Island College (855-06-56)
- 4:30 p.m. *σ -manuals. Preliminary report.*
(57) **Alexander Wilce**, University of New Hampshire (855-06-160)
- 5:00 p.m. *Convergence of observables on quantum logics.*
(58) **Stanley Gudder**, University of Denver (855-06-03)

Friday, March 16 (cont'd)

Special Session on Numerical Analysis, I

3:00 p.m.-5:20 p.m. Room 122, Cardwell Hall

- 3:00 p.m. *Vortex dynamics of hovering mode. Preliminary report.*
(59) **Karl Gustafson**, University of Colorado, Boulder (855-65-05) (Sponsored by Albert T. Lundell)
- 3:30 p.m. *Quasimolecular fluid modeling.*
(60) **Donald Greenspan**, University of Texas, Arlington (855-65-78)
- 4:00 p.m. *Lyapunov-Schmidt reduction for the crossing of two neutral curves in Taylor-Couette flow.*
(61) **John H. Bolstad***, University of California, Livermore, and **Michael E. Henderson**, IBM T. J. Watson Research Center, Yorktown Heights, New York (855-65-77)
- 4:30 p.m. *Bifurcation of periodic solutions of singularly perturbed delay differential equation.*
(62) **Abdullah J. Tamraz**, Wichita State University (855-65-128)
- 5:00 p.m. *Numerical computation of water waves in a potential flow.*
(63) **C. H. Su**, Brown University (855-65-76) (Sponsored by Qisu Zou)

Special Session on Geometric Function Theory, II

3:00 p.m.-6:20 p.m. Room 144, Cardwell Hall

- 3:00 p.m. *On some almost everywhere overdetermined boundary value problems.*
(64) **John Lewis*** and **Andrew Vogel**, University of Kentucky (855-31-22)
- 3:30 p.m. *Note on A_∞ and level sets of conformal mappings.*
(65) Preliminary report.
Juha Heinonen, University of Michigan, Ann Arbor (855-30-102)
- 4:00 p.m. *The Dirichlet problem for the ∞ -Laplacian. Preliminary report.*
(66) **Tilak Bhattacharya**, **Emanuelle DiBenedetto**, Northwestern University, and **Juan Manfredi***, University of Pittsburgh, Pittsburgh (855-35-116)
- 4:30 p.m. *Composition operators and angular derivatives.*
(67) **Tom Carroll**, Purdue University, West Lafayette (855-30-140) (Sponsored by John F. Rossi)
- 5:00 p.m. *Discrete quasiconformal groups with small dilatation.*
(68) **M. Jean McKemie**, St. Edward's University (855-30-94)
- 5:30 p.m. *Boundary values for some classes of functions. Preliminary report.*
(69) **Enrique Villamor**, Florida International University (855-30-115)

- 6:00 p.m. *Generalised conformal welding.*
(70) **David H. Hamilton**, University of Maryland, College Park (855-30-57) (Sponsored by John F. Rossi)

Special Session on Partial Differential Equations, II

3:00 p.m.-5:50 p.m. Room 129, Cardwell Hall

- 3:00 p.m. *A Riemann-Lebesgue lemma for mathematical ecology.*
(71) **Robert Stephen Cantrell*** and **Chris Cosner**, University of Miami (855-35-125)
- 3:30 p.m. *Positive solutions of systems of nonlinear eigenvalue problems.*
(72) **Nela Lakoš**, Ohio State University, Columbus (855-35-182)
- 4:00 p.m. *Minimal solutions of superlinear equations.*
(73) **Allan Edelson**, University of California, Davis (855-35-194)
- 4:30 p.m. *Semilinear elliptic problems at resonance - some space dimension dependent results.*
(74) **Renate Schaaf*** and **Klaus Schmitt**, University of Utah (855-35-100) (Sponsored by Klaus Schmitt)
- 5:00 p.m. *Towards a theory for quasilinear PDEs in structured population dynamics. Preliminary report.*
(75) **Horst R. Thieme**, Arizona State University (855-35-199)
- 5:30 p.m. *Rearrangements and vorticity.*
(76) **Alan Elcrat*** and **Kenneth Miller**, Wichita State University (855-34-84)

Special Session on Commutative Algebra, II

3:00 p.m.-5:50 p.m. Room 102, Cardwell Hall

- 3:00 p.m. *Curve singularities of finite Cohen-Macaulay type.*
(77) **Roger Wiegand**, University of Nebraska, Lincoln (855-13-197)
- 3:30 p.m. *Local cohomology of Rees algebras and Hilbert functions. Preliminary report.*
(78) **Bernard Johnston*** and **Jugal Verma**, Louisiana State University, Baton Rouge (855-13-144)
- 4:00 p.m. *Modules with linear syzygies. Preliminary report.*
(79) **David Eisenbud**, Brandeis University, and **Jee Koh**, Indiana University, Bloomington (855-13-143)
- 4:30 p.m. *Étale cohomology and the topology of algebraic varieties.*
(80) **Gennady Lyubeznik**, University of Chicago (855-14-142)
- 5:00 p.m. *Unmixed local rings of type two are Cohen-Macaulay.*
(81) **Thomas Marley**, University of Nebraska, Lincoln (855-13-176)
- 5:30 p.m. *Canonical resolution of hypersurface singularities of characteristic zero.*
(82) **T. T. Moh**, Purdue University, West Lafayette (855-13-177)

Special Session on Inverse Problems and Scattering Theory, II

3:00 p.m.-5:30 p.m. Room 143, Cardwell Hall

- 3:00 p.m. *Inverse scattering at fixed energy in three dimensions.*
(83) **A. G. Ramm**, University of Kansas (855-35-27)
- 3:55 p.m. *Two inverse problems for partial differential equations.*
(84) **Mikhail V. Klibanov**, Courant Institute of Mathematical Sciences, New York University (855-35-63) (Sponsored by Rakesh)
- 4:50 p.m. *Clifford Tori and overdetermined problems.*
(85) Preliminary report.
Carlos Berenstein* and **Max Karlovitz**, University of Maryland, College Park (855-35-60)

Special Session on Ergodic Theory, II

3:00 p.m.-5:20 p.m. Room 130, Cardwell Hall

- 3:00 p.m. *Cayley graphs and recurrence in dynamical systems.*
(86) **Alan Forrest**, Ohio State University, Columbus (855-28-38)
- 3:30 p.m. *Some remarks on the convergence of weighted ergodic averages.* Preliminary report.
(87) **I. Kornfeld**, North Dakota State University (855-28-149) (Sponsored by Dogan Comez)
- 4:00 p.m. *Random sampling of stationary processes.*
(88) **Karl Petersen**, University of North Carolina, Chapel Hill (855-28-62)
- 4:30 p.m. *On almost everywhere convergence of convolution powers in $L^1(X)$.* Preliminary report.
(89) **Karin Reinhold-Larsson**, Ohio State University, Columbus (855-28-148)
- 5:00 p.m. *Two applications of a theorem on invariant measures for multiplication.*
(90) **Daniel J. Rudolph**, University of Maryland, College Park (855-28-181)

Special Session on Graph Theory, II

3:00 p.m.-5:20 p.m. Room 146, Cardwell Hall

- 3:00 p.m. *Unavoidable subgraphs of sparse graphs: Lagnappe.*
(91) **C. A. Barefoot**, **L. H. Clark**, **R. C. Entringer***, **A. A. Kooshesh** and **L. A. Székely**, University of New Mexico (855-05-75)
- 3:30 p.m. *Homomorphisms with the lifting property.*
(92) **Bennet Manvel*** and **Richard Osborne**, Colorado State University (855-05-93) (Sponsored by Richard H. Schelp)
- 4:00 p.m. *A prime number theorem for normed graphs.*
(93) Preliminary report.
Robin J. Wilson, Open University, England (855-05-112) (Sponsored by Richard H. Schelp)
- 4:30 p.m. *Size and independence in triangle-free graphs with fixed maximum degree.* Preliminary report.
(94) **Kathryn F. Jones**, University of Colorado (855-05-88)

- 5:00 p.m. *An upper bound for the average number of regions.*
(95) Preliminary report.
Saul Stahl, University of Kansas (855-05-21)

Special Session on Groups and Geometries, II

3:00 p.m.-4:50 p.m. Room 145, Cardwell Hall

- 3:00 p.m. *High-weight modules for quotients of affine buildings.*
(96) **Stephen D. Smith**, University of Illinois, Chicago (855-20-11)
- 3:30 p.m. $Ru \leq E_7(5)$.
(97) **Ulrich Meierfrankenfeld**, Michigan State University (855-20-159) (Sponsored by Jonathan I. Hall)
- 4:00 p.m. *Groups generated by 3-transpositions.* Preliminary report.
(98) **Jonathan I. Hall**, Michigan State University (855-20-107)
- 4:30 p.m. Informal Discussion

Special Session on Applications of Category Theory, II

3:00 p.m.-5:20 p.m. Room 103, Cardwell Hall

- 3:00 p.m. *Categorical foundations and set theory.*
(99) **Saunders Mac Lane**, University of Chicago (855-18-15)
- 3:30 p.m. *Does anybody really know what a Hopf algebra is?*
(100) Preliminary report.
Robert Pare, Dalhousie University (855-18-42) (Sponsored by Keith P. Johnson)
- 4:00 p.m. *Metatheory of Boolean categories.* Preliminary report.
(101) **Ernest G. Manes**, University of Massachusetts, Amherst (855-18-35) (Sponsored by Frank A. Wattenberg)
- 4:30 p.m. *Weak adjunctions between categories of CPO's.*
(102) Preliminary report.
Michael W. Mislove, Tulane University, and **Frank J. Oles***, University of Pennsylvania and IBM T. J. Watson Research Center, Yorktown Heights, New York (855-68-127)
- 5:00 p.m. *Completions of continuous posets and modules of concurrency.*
(103) **Michael W. Mislove**, Tulane University (855-68-192)

General Session

3:00 p.m.-4:30 p.m. Room 120, Cardwell Hall

- 3:00 p.m. *The value of certain determinants with elements zero and one.* Preliminary report.
(104) **Dale Woods*** and **D. J. Boyce**, Central State University (855-15-136)
- 3:20 p.m. *Total cosine of normal matrices.* Preliminary report.
(105) **Morteza Seddighin**, Panhandle State University (855-15-147) (Sponsored by Andy R. Magid)

Friday, March 16 (cont'd)

- 3:40 p.m. *Expansions of chromatic polynomials and log-concavity.*
(106) **Francesco Brenti**, University of Michigan, Ann Arbor (855-05-41)
- 4:00 p.m. *An inverse convolution method for regular parabolic equations.*
(107) **B. A. Mair***, University of Florida, **D. S. Gilliam** and **C. F. Martin**, Texas Tech University (855-35-45)
- 4:20 p.m. *Badug tablet.*
(108) **Myungkark Park**, Prompter Publications, Cincinnati, Ohio (855-11-201)

Saturday, March 17

Special Session on Geometric Function Theory, III

8:00 a.m.-10:50 a.m. Room 144, Cardwell Hall

- 8:00 a.m. *A maximum principle for the Bergman space.*
(109) **Boris Korenblum**, State University of New York, Albany (855-30-04)
- 8:30 a.m. *Maximal functions, A_∞ -measures and quasiconformal maps.*
(110) **Susan G. Staples**, University of Texas, Austin (855-30-104)
- 9:00 a.m. *The quasihyperbolic metric is exponentially integrable on Hölder domains in R^n . Preliminary report.*
(111) **Wayne Smith**, University of Washington, and **David A. Stegenga***, University of Hawaii, Honolulu (855-30-110)
- 9:30 a.m. *The boundary distributions of analytic functions on the disc.*
(112) **Carl Sundberg**, University of Tennessee, Knoxville (855-30-135)
- 10:00 a.m. *The BMOA-distance of a function from VMOA. Preliminary report.*
(113) **David Stegenga**, University of Hawaii, Manoa, and **Kenneth Stephenson***, University of Tennessee, Knoxville (855-30-134)
- 10:30 a.m. *The Cauchy integral operator and the eigenvalue problem for the Laplacian.*
(114) **Dmitry Khavinson***, University of Arkansas, Fayetteville, **J. M. Anderson**, University College, England, and **Victor Lomonosov**, Moscow, USSR (855-30-10)

Special Session on Partial Differential Equations, III

8:00 a.m.-10:20 a.m.

Room 129, Cardwell Hall

- 8:00 a.m. *Fully nonlinear parabolic boundary value problems in higher space dimensions, II.*
(115) **Chin-Yuan Lin**, Texas A & M University, College Station (855-35-53)
- 8:30 a.m. *Bifurcation turning points in combustion equations. Preliminary report.*
(116) **Karl Gustafson**, University of Colorado, Boulder (855-35-06) (Sponsored by Albert T. Lundell)
- 9:00 a.m. *Optimal control for elliptic Volterra-Lotka type equations.*
(117) **Anthony Leung*** and **Srdjan Stojanovic**, University of Cincinnati (855-35-154)
- 9:30 a.m. *Reaction-diffusion models and elliptic eigenvalue problems. Preliminary report.*
(118) **Chris Cosner**, University of Miami (855-35-155)
- 10:00 a.m. *The wave equation with nonlinear boundary conditions.*
(119) **Irena Lasiecka**, University of Virginia, and **Andreas Stahel***, University of Utah (855-35-153)

Special Session on Graph Theory, III

8:00 a.m.-10:50 a.m.

Room 146, Cardwell Hall

- 8:00 a.m. *Edge-graceful cubic graphs.*
(120) **John Watkins**, Colorado College (855-05-91)
- 8:30 a.m. *Ramsey problems and their relation to Turan type extremal problems.*
(121) **R. J. Faudree***, Memphis State University, and **M. Simonovits**, Hungarian Academy of Sciences, Hungary (855-05-111)
- 9:00 a.m. *On peripheral vertices in graphs.*
(122) **Gary Chartrand***, Western Michigan University, **Garth A. Jones**, Saginaw Valley State University, and **Ortrud Oellermann**, University of Natal, South Africa (855-05-92)
- 9:30 a.m. *Some unconventional games on graphs. Preliminary report.*
(123) **Paul Erdős**, Hungarian Academy of Sciences, Hungary (855-05-65)
- 10:00 a.m. *Minimum Boolean factorization of tournament codes.*
(124) **Greg Bain**, **J. Richard Lundgren***, University of Colorado, Denver, and **John S. Maybee**, University of Colorado, Boulder (855-05-71)
- 10:30 a.m. *The dimension of a random partial order of height n .*
(125) **W. T. Trotter***, **H. Kierstead**, Arizona State University, and **P. Erdős**, Hungarian Academy of Sciences, Hungary (855-05-101)

Special Session on Groups and Geometries, III

8:00 a.m.-10:50 a.m. Room 145, Cardwell Hall

- 8:00 a.m. *Affine Λ -buildings.*
(126) **Curtis Bennett**, University of Chicago (855-51-66)
- 8:30 a.m. *Extended generalized polygons.*
(127) **Richard Weiss**, Tufts University (855-20-13)
- 9:00 a.m. *The embeddings of flag-transitive classical locally polar geometries of rank 3.*
(128) **Satoshi Yoshiara**, Tufts University (855-51-34)
- 9:30 a.m. *Embeddings of polar spaces.* Preliminary report.
(129) **Peter M. Johnson**, Wayne State University (855-51-172)
- 10:00 a.m. *Locally polar spaces with affine planes.* Preliminary report.
(130) **Hans Cuypers***, Michigan State University, and **Antonio Pasini**, University of Naples, Italy (855-51-106) (Sponsored by Jonathan I. Hall)
- 10:30 a.m. *Totally irregular collineation groups.* Preliminary report.
(131) **Chat Yin Ho**, University of Florida (855-20-23) (Sponsored by Ernest E. Shult)

Special Session on Commutative Algebra, III

8:30 a.m.-10:50 a.m. Room 102, Cardwell Hall

- 8:30 a.m. *Strongly regular ring.*
(132) **Budh Nashier**, Florida State University (855-13-122)
- 9:00 a.m. *Conormal bundle of determinantal curves.*
(133) **A. Prabhakar Rao**, University of Missouri, St. Louis (855-14-178)
- 9:30 a.m. *Rings with low dimensional formal fibres.* Preliminary report.
(134) **Christel Rotthaus**, Michigan State University (855-13-16)
- 10:00 a.m. *Space curves as complete intersection.* Preliminary report.
(135) **Avinash Sathaye*** and **Jon Stenerson**, University of Kentucky (855-14-195)
- 10:30 a.m. *Zero cycles and the number of generators of modules.*
(136) **M. P. Murthy**, University of Chicago (855-13-123)

Special Session on Inverse Problems and Scattering Theory, III

8:30 a.m.-10:50 a.m. Room 143, Cardwell Hall

- 8:30 a.m. *Inversion of the backscatter data in the 3D potential scattering problem.*
(137) **Reese T. Prosser**, Dartmouth College (855-81-156)
- 9:20 a.m. *Inverse spectral theory in one and two dimensions.*
(138) **Roger Knobel** and **Joyce R. McLaughlin***, Rensselaer Polytechnic Institute (855-34-174)

- 10:10 a.m. *On an inverse boundary value problem in two dimensions.*
(139) **Ziqi Sun**, University of Washington (855-35-01)

Special Session on Harmonic Analysis and Probability Theory, III

9:00 a.m.-10:50 a.m. Room 131, Cardwell Hall

- 9:00 a.m. *Another lacunarity property for Fourier series.*
(140) **Kenneth A. Ross**, University of Oregon (855-43-55)
- 9:30 a.m. *A homomorphism theorem for maximal multiplier transforms.*
(141) **Nakhle' Asmar***, University of Missouri, Columbia, **Earl Berkson**, University of Illinois, Urbana-Champaign, and **T. Alastair Gillespie**, University of Edinburgh, Scotland (855-43-17)
- 10:00 a.m. *Theta function of a Riemannian manifold with boundary.* Preliminary report.
(142) **Pei Hsu**, Northwestern University (855-58-64) (Sponsored by Andrew G. Bennett)
- 10:30 a.m. *The angular part of Brownian motion on negatively curved Riemannian manifolds.* Preliminary report.
(143) **Anton Thalmaier**, University of Texas, Austin (855-60-99)

Special Session on Orthostructures, III

9:00 a.m.-10:50 a.m. Room 121, Cardwell Hall

- 9:00 a.m. *Constructible hypergraphs.*
(144) **Christian Schindler**, University of Denver (855-05-186)
- 9:30 a.m. *Generalized measure theory on orthostructures.*
(145) **Gottfried T. Rüttimann**, University of Bern, Switzerland (855-28-167)
- 10:00 a.m. *An undecidability result in lattice theory.*
(146) **Otmar Spinas**, Mathematisches Institut Universität Zürich, Switzerland (855-06-169) (Sponsored by David J. Foulis)
- 10:30 a.m. *Maximum likelihood estimation on quasimanuals.*
(147) **Matthias P. Kläy***, Sandoz AG, Switzerland, and **David J. Foulis**, University of Massachusetts, Amherst (855-60-165)

Special Session on Numerical Analysis, II

9:00 a.m.-10:50 a.m. Room 122, Cardwell Hall

- 9:00 a.m. *Series expansions for solitary waves.*
(148) **Steve Pennell**, University of Lowell (855-65-79)
- 9:30 a.m. *Simulations of incompressible flows containing interfaces using front tracking methods.*
(149) **Gretar Tryggvason***, **Ozen Unverdi** and **Kahled Sbeih**, University of Michigan, Ann Arbor (855-65-82) (Sponsored by Qisu Zou)

Saturday, March 17 (cont'd)

- 10:00 a.m. A second-order accurate scheme for the
(150) *incompressible Navier-Stokes equations*.
John Strikwerda, University of Wisconsin, Madison
(855-65-80)
- 10:30 a.m. A new class of nonoscillatory discontinuous Galerkin
(151) *finite element methods for conservation laws in multidimensions*.
Bernardo Cockburn, Suchung Hou, University of Minnesota, Minneapolis, and **Chi-Wang Shu***, Brown University (855-65-81)

Special Session on Ergodic Theory, III

9:00 a.m.-10:50 a.m. Room 130, Cardwell Hall

- 9:00 a.m. *On the converse of the dominated ergodic theorem*.
(152) **Laszlo I. Szabo**, Ohio State University, Columbus
(855-28-97) (Sponsored by Joseph M. Rosenblatt)
- 9:30 a.m. *Measures with prescribed marginals, extreme points
(153) and measure preserving transformations*. Preliminary report.
M. B. Rao*, North Dakota State University, and **K. Subramanyam**, University of North Carolina, Wilmington (855-28-151) (Sponsored by Dogan Comez)
- 10:00 a.m. *Almost everywhere divergence and the "strong
(154) sweeping out property"*.
Alexandra Bellow, Northwestern University
(855-28-105)
- 10:30 a.m. *Weak sequential compactness and a. e. convergence
(155) of Cesaro averages*. Preliminary report.
Dogan Comez, North Dakota State University
(855-47-150)

Special Session on Applications of Category Theory, III

9:00 a.m.-10:50 a.m. Room 103, Cardwell Hall

- 9:00 a.m. *Topological Eilenberg-Moore algebras*.
(156) **Sergio Salbany***, University of Zimbabwe, Zimbabwe, and **D. Pumplün**, Fern Universität Hagen, Federal Republic of Germany (855-18-28) (Sponsored by George E. Strecker)
- 9:30 a.m. *Regular closure operators and compactness*.
(157) **Gabriele Castellini**, University of Puerto Rico, Mayagüez (855-18-19)
- 10:00 a.m. *Appropriate domains for infinite dimensional calculus*.
(158) Preliminary report.
L. D. Nel, Carleton University (855-58-30)
- 10:30 a.m. *Special objects in the category of Γ -convex spaces*.
(159) Preliminary report.
Helmut Rohrl, La Jolla, California (855-18-20)

Invited Address

11:00 a.m.-noon

Room 101, Cardwell Hall

- (160) *Examples of Cauchy-Riemann structures*.
Jean-Pierre Rosay, University of Wisconsin, Madison
(855-32-202)

Invited Address

1:30 p.m.-2:30 p.m.

Room 101, Cardwell Hall

- (161) *Harmonic measure and applications*.
Jang-Mei Wu, University of Illinois, Urbana-Champaign (855-30-90)

Special Session on Harmonic Analysis and Probability Theory, IV

3:00 p.m.-5:20 p.m.

Room 131, Cardwell Hall

- 3:00 p.m. *Nonexplosion of a stochastic partial differential
(162) equation*. Preliminary report.
Carl Mueller, University of Rochester (855-60-189)
- 3:30 p.m. *Gradient estimates using coupling*.
(163) **Michael Cranston**, University of Rochester
(855-60-108)
- 4:00 p.m. *Exponentially fast uniform convergence in one
(164) dimensional stochastic Ising models*.
Richard Holley*, University of Colorado, Boulder, and
Dan Stroock, Massachusetts Institute of Technology
(855-60-44)
- 4:30 p.m. *Lifetime distribution of h processes*.
(165) **Burgess Davis**, Purdue University, West Lafayette
(855-60-67)
- 5:00 p.m. *Sharp square-function inequalities for conditionally
(166) symmetric martingales*.
Gang Wang, Purdue University, West Lafayette
(855-60-09)

Special Session on Orthostructures, IV

3:00 p.m.-4:50 p.m.

Room 121, Cardwell Hall

- 3:00 p.m. *Profinite orthomodular lattices*.
(167) **Tae Ho Choe***, McMaster University, and **Richard Greechie**, Kansas State University (855-06-50)
- 3:30 p.m. *Blocks and commutators in orthomodular lattices*.
(168) **Günter Bruns**, McMaster University, and **Richard Greechie***, Kansas State University (855-06-164)
- 4:00 p.m. *Orthomodular structures from sesquilinear forms*.
(169) **Robert Piziak**, Baylor University (855-06-166)
- 4:30 p.m. *A method of constructing orthomodular lattices*.
(170) **John R. Harding**, McMaster University (855-06-168)

Special Session on Numerical Analysis, III

3:00 p.m.-4:50 p.m. Room 122, Cardwell Hall

- 3:00 p.m. *A least-squares finite element method for Helmholtz equation.*
(171) **Ching Lung Chang**, Cleveland State University (855-35-83) (Sponsored by J. A. Chao)
- 3:30 p.m. *Numerical simulation of gas-solid fluid flows.*
(172) **Yue-Kuen Kwok**, San Jose State University (855-65-46) (Sponsored by Qisu Zou)
- 4:00 p.m. *Lattice gas automata - a new method for solving the Navier-Stokes equations.*
(173) **Shiyi Chen*** and **Gary D. Doolen**, Los Alamos National Laboratory (855-65-129) (Sponsored by Qisu Zou)
- 4:30 p.m. *A comparison of some numerical conformal mapping methods for exterior regions.*
(174) **Thomas K. DeLillo*** and **Alan R. Elcrat**, Wichita State University (855-65-130)

Special Session on Geometric Function Theory, IV

3:00 p.m.-6:20 p.m. Room 144, Cardwell Hall

- 3:00 p.m. *Goluzin inequalities and minimum energy for mappings onto nonoverlapping regions.*
(175) **P. L. Duren***, University of Michigan, Ann Arbor, and **M. M. Schiffer**, Stanford University (855-30-58)
- 3:30 p.m. *On a fixed area problem.* Preliminary report.
(176) **Y. J. Leung**, University of Delaware (855-30-175) (Sponsored by Joseph S. Hemmeter)
- 4:00 p.m. *Linear invariance and uniform local univalence.*
(177) **Wancang Ma** and **David Minda***, University of Cincinnati (855-30-198)
- 4:30 p.m. *Extremal distance and quasiconformal circle domains.*
(178) Preliminary report.
David A. Herron*, University of Cincinnati, and **Pekka Koskela**, University of Jyväskylä, Finland (855-30-117)
- 5:00 p.m. *Some numerical calculations related to the Riemann Hypothesis.* Preliminary report.
(179) **Karl Barth**, Syracuse University (855-30-120)
- 5:30 p.m. *Iteration and zeros of the second derivative.*
(180) **A. Hinkkanen**, University of Texas, Austin (855-30-103)
- 6:00 p.m. *Real zeros of the second derivative of the reciprocal of an entire function.*
(181) **George Csordas**, **Wayne Smith*** and **Jack Williamson**, University of Hawaii, Honolulu (855-30-133)

Special Session on Partial Differential Equations, IV

3:00 p.m.-4:50 p.m. Room 129, Cardwell Hall

- 3:00 p.m. *Existence of travelling wave solutions for an evolutionary ecology model.*
(182) **Roger Lui**, University of Utah (855-35-33)
- 3:30 p.m. *Slow motion manifolds for the Cahn-Hilliard equation in 1 space dimension.*
(183) **Nicholas D. Alikakos**, University of Tennessee, Knoxville (855-35-203)
- 4:00 p.m. Informal Discussion

Special Session on Commutative Algebra, IV

3:00 p.m.-5:50 p.m. Room 102, Cardwell Hall

- 3:00 p.m. *Linear triangularization of homogeneous polynomial maps.* Preliminary report.
(184) **David Wright**, Washington University (855-13-98)
- 3:30 p.m. *Ranks of indecomposable modules over one-dimensional rings, II.* Preliminary report.
(185) **Leo Chouinard** and **Sylvia Wiegand***, University of Nebraska, Lincoln (855-13-158)
- 4:00 p.m. *On the structure of certain normal ideals.* Preliminary report.
(186) **Craig Huneke**, Purdue University, West Lafayette, **Volmer Vasconcelos**, Rutgers University, New Brunswick, and **Bernd Ulrich***, Michigan State University (855-13-119)
- 4:30 p.m. *Rees algebras of two-dimensional Cohen-Macaulay local rings.* Preliminary report.
(187) **Jugal Verma**, Louisiana State University, Baton Rouge (855-13-145) (Sponsored by Tomasz Przebinda)
- 5:00 p.m. *Divisorial properties of the canonical module for invariant subrings.*
(188) **Dana T. Weston**, University of Missouri, Columbia (855-13-32)
- 5:30 p.m. *On the non-existence of a minimal algebra resolution despite vanishing of Avramov obstructions.*
(189) **Hema Srinivasan**, University of Missouri, Columbia (855-13-121)

Special Session on Inverse Problems and Scattering Theory, IV

3:00 p.m.-5:20 p.m. Room 143, Cardwell Hall

- 3:00 p.m. Informal Discussion

Saturday, March 17 (cont'd)

Special Session on Ergodic Theory, IV

- 3:00 p.m.-4:50 p.m.** Room 130, Cardwell Hall
- 3:00 p.m. *Multiparameter and subsequence ergodic theorems.*
(190) **James H. Olsen**, North Dakota State University (855-47-131)
- 3:30 p.m. *Mixing examples in the class of piecewise continuous and expanding interval maps.*
(191) **Christopher Bose**, University of Victoria (855-28-124)
(Sponsored by Joseph M. Rosenblatt)
- 4:00 p.m. *Polynomial van der Waerden implies polynomial Szemerédi.*
(192) **Vitaly Bergelson**, Ohio State University, Columbus (855-28-180)
- 4:30 p.m. *Counterexamples from Gaussian automorphisms.*
(193) **Andrés del Junco**, University of Toronto (855-28-190)

Special Session on Groups and Geometries, IV

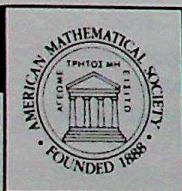
- 3:00 p.m.-5:50 p.m.** Room 145, Cardwell Hall
- 3:00 p.m. *Generalized quadrangles with $s = t^2$: A survey of recent results.*
(194) **Stanley E. Payne**, University of Colorado, Denver (855-51-126)
- 3:30 p.m. *Skeletons of conical flocks.*
(195) **Norman L. Johnson**, University of Iowa (855-51-26)
(Sponsored by Ernest E. Shult)
- 4:00 p.m. *Generalized quadrangles in p -groups.*
(196) **Diane Herrmann**, University of Chicago (855-20-132)

- 4:30 p.m. *Restrictions on groups with a Kantor family.*
(197) Preliminary report.
Xu Ming Chen and **Daniel Frohardt***, Wayne State University (855-20-171)
- 5:00 p.m. *Orthogonal resolutions of designs.*
(198) **Spyros S. Magliveras**, University of Nebraska, Lincoln (855-05-61)
- 5:30 p.m. Informal Discussion

Special Session on Applications of Category Theory, IV

- 3:00 p.m.-5:20 p.m.** Room 103, Cardwell Hall
- 3:00 p.m. *An internal characterization of β .*
(199) **Guenther E. Richter**, University of Bielefeld, Federal Republic of Germany (855-18-25)
- 3:30 p.m. *Enriched category theory based on relations.*
(200) Preliminary report.
Jurgen Koslowski, Macalester College (855-18-47)
- 4:00 p.m. *A -epimorphisms, diagonal-separation, and disconnectedness.*
(201) **Harriet M. Lord**, California State Polytechnic University (855-18-14)
- 4:30 p.m. *Topological universe hulls inside the category of pseudotopological spaces.*
(202) **Friedhelm Schwarz**, University of Toledo (855-18-45)
- 5:00 p.m. *Completely regular spaces.* Preliminary report.
(203) **H. L. Bentley***, University of Toledo, and **E. Lowen-Colebunders**, Free University of Brussels, Belgium (855-54-59)

Andy Roy Magliveras
Associate Secretary
Norman, Oklahoma



GROUP ACTIONS AND INVARIANT THEORY

A. Bialynicki-Birula, J. Carrell, P. Russell, and D. Snow, Editors
(Conference Proceedings, Canadian Mathematical Society, Volume 10)

This volume contains the proceedings of a conference, sponsored by the Canadian Mathematical Society, on Group Actions and Invariant Theory, held in August, 1988 in Montreal. The conference was the third in a series bringing together researchers from North America and Europe (particularly Poland). The papers collected here will provide an overview of the state of the art of research in this area. The conference was primarily concerned with the geometric side of invariant theory, including explorations of the linearization problem for reductive group actions on affine spaces (with a counterexample given recently by J. Schwarz), spherical and complete symmetric varieties, reductive quotients, automorphisms of affine varieties, and homogeneous vector bundles.

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Fayetteville, Arkansas

University of Arkansas

March 23 - 24

Progra

The eight-hundred-and-fifty-sixth meeting of the American Mathematical Society will be held at the University of Arkansas in Fayetteville, Arkansas on Friday, March 23, and Saturday, March 24, 1990. This meeting will be held in conjunction with the University of Arkansas' Fourteenth Annual Lecture Series in Mathematical Sciences, and in cooperation with the Society for Industrial and Applied Mathematics (SIAM). All sessions will be held in the Center for Continuing Education.

Invited Addresses

By invitation of the Southeastern Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks, and the scheduled times of presentation are:

MARCEL F. NEUTS, University of Arizona, *Phase-type distributions: Basic properties*, 11:00 a.m. Friday. This talk is part of the University of Arkansas' Fourteenth Annual Lecture Series and is in cooperation with SIAM. The three remaining talks in the Lecture Series will occur in the Special Session on *Probability distributions of phase type and applications*, also being held in cooperation with SIAM.

VLADIMIR I. OLIKER, Emory University, *Selected non-linear problems in geometry*, 1:00 p.m. Friday.

MARK A. STERN, Duke University and the Institute for Advanced Study, *A geometric trace formula for Hecke operators*, 11:00 a.m. Saturday.

JONATHAN M. WAHL, University of North Carolina, Chapel Hill, *Topology and geometry of isolated complex surface singularities*, 1:00 p.m. Saturday.

Special Sessions

By invitation of the same committee, there will be nine special sessions of selected twenty-minute papers. The topics, the names and affiliations of the organizers, and the speakers are as follows:

Singular integral operators and related areas, GERALDO SOARES DE SOUZA and GARY SAMPSON, Auburn University, Auburn. Kenneth F. Andersen, John Gilbert,

Cristian E. Gutiérrez, Björn Jawerth, Peter M. Knudsen, Dan Oberlin, Rodolfo H. Torres, Tavan T. Trent, J. L. Wang, and J. Michael Wilson.

Banach algebras, JOHN DUNCAN, University of Arkansas. Bruce Barnes, David P. Blecher, Peter Detre, F. Ghahramani, Sandy Grabiner, N. J. Kalton, Herbert Kamowitz, Anthony To-Ming Lau, Michael Neumann, Theodore W. Palmer, and Marc P. Thomas.

Semigroups in geometry and analysis, KARL H. HOFMANN and JIMMIE D. LAWSON, Louisiana State University, Baton Rouge. Mitchell J. Anderson, Norbert D. Anselm Eggert, Paul Ehrlich, Karl H. Hofmann, J. Holmes, Palle E. T. Jorgensen, Arunava Mukherjee, Karl-Hermann Neeb, Mohan S. Putcha, Wolfgang Ruppert, Boris M. Schein, James W. Stepp, Christa Terp, and Wolfgang Weiss.

On complex function theory of one and several variables, DIMA KHAVINSON, University of Arkansas, Fayetteville. John T. Anderson, Albert Baernstein II, R. W. Barnard, P. L. Duren, A. Hinkkanen, Steven Krantz, Marius Overholt, Richard Rochberg, Zbigniew Slodkowski, Emil J. Straube, and John Wermer.

Phase-type distributions and some applications, E. MONROE and COLM A. O'CINNEIDE, University of Arkansas, Fayetteville. The three remaining talks of the Fourteenth Lecture Series will occur during this Special Session. Soren Asmussen, C. Blondia, Andrea Bobbio, Chakravarthy, Mary A. Johnson, Lester Lipsky, David Lucantoni, Marcel F. Neuts, Marcel F. Neuts, Marcel Neuts, Colm O'Cinneide, V. Ramaswami, Ushio Shikishima, Kishor Trivedi, and Appie van de Liefvoort.

Algebraic geometry, DAVID R. MORRISON, Duke University, and JONATHAN M. WAHL. Paolo Aluffi, Arapura, Bruce Crauder, Brian Harbourne, David Jaffe, Sheldon Katz, Rick Miranda, David R. Morrison, Kieran O'Grady, Mark Spivakovsky, and Jan Stevens.

Geometry, physics and nonlinear PDE's, VLADIMIR I. OLIKER and ANDREJS E. TREIBERGS, University of Arkansas, Fayetteville. I. Bakelman, John K. Beem, Eugenio Calabi, Jaigil Choe, Dennis DeTurck, P. Ehrlich, José F. Escobar, J. Firey, Michael E. Gage, Samuel I. Goldberg, Gordon, Robert Hardt, R. Howard, Gary R. Jones.

Bernhard Kawohl, Nicholas J. Korevaar, Jeffrey Lee, G. Liao, Erwin Lutwak, Robert C. McOwen, Daniel Phillips, Ernst A. Ruh, Friedmar Schulz, Andrejs E. Treibergs, S. Walter Wei, Henry C. Wente, Frederico Xavier, and Paul C. Yang.

Combinatorics, JAMES G. OXLEY, Louisiana State University. Safwan Akkari, Nathaniel Dean, Bradley S. Gubser, Hugh Hind, Bogdan Oporowski, James G. Oxley, M. D. Plummer, Talmage James Reid, Neil Robertson, Gordon F. Royle, William Schmitt, W. D. Wallis, and James A. Wiseman.

Differential geometry, WILLIAM L. PARDON, Duke University, and MARK A. STERN. Joseph H. G. Fu, Peter Haskell, Werner Muller, Alan M. Nadel, William Pardon, Sai Kee Yeung, and Fangyang Zheng.

Abstracts for consideration for these sessions should have been submitted by the **November 21, 1989** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be a session for contributed ten-minute papers. Late papers will not be accommodated.

Registration

The meeting registration desk will be located on the second floor (street level) of the Center for Continuing Education located on the square in downtown Fayetteville at the corner of East Avenue and Center Street. The meeting registration desk will be open from 8:00 a.m. to 5:00 p.m. on Friday, March 23, and from 8:00 a.m. to noon on Saturday, March 24.

The registration fees are \$30 for members of the AMS or SIAM, \$45 for nonmembers, and \$10 for students and unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

David II Report

There will be a special presentation and discussion Friday evening at 7:15 p.m. concerning the upcoming National Research Council David II Report. A written executive summary of David II will be available to participants. This report is to be issued this spring and could have a major impact on all mathematics departments. The focus will be on becoming familiar with the report and discussing its use in our work.

Accommodations

A block of rooms is being held in the Fayetteville Hilton adjacent to the Center for Continuing Education. Rates of \$49 for a single room and \$56 for a double room will be offered to participants making reservations **no later than March 8, 1990**. After that date the rates listed below will apply. Participants should make their own reservations directly with the Hilton and with the hotels listed below and identify themselves as participants of the AMS meeting in order to obtain the rates listed. All rates are subject to a nine percent tax. Distances given below are driving distances measured from the Center for Continuing Education. The AMS is not responsible for rate changes or accommodations offered by hotels/motels.

Fayetteville Hilton

70 North East Street, Fayetteville, AR 72701
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Single \$58 Double \$69

Above rates for reservations made after March 8, 1990.

Mountain Inn (one block)

21 South College (Hwy. 471), Fayetteville, AR 72701
Telephone: 501-521-1000 or 800-336-7133

Single \$27 Double \$29

Best Western Motel (two-and-one-half miles)

1000 Hwy 71, Fayetteville, AR 72701
Telephone: 501-442-3041 or 800-528-1234

Single \$35 Double \$39

Motel 6 (three miles)

2980 North College, Fayetteville, AR 72701
Telephone: 317-741-7777

Single \$19.95 Double \$25.95

Park Inn (two-and-one-half miles)

1255 Shiloh Drive, Fayetteville, AR 72701
Telephone: 501-521-1166 or 800-437-7275

Single \$44 Double \$46

Food Service

There are a number of restaurants on the square and in the downtown area. Complete listings will be available at the meeting registration desk.

Travel

Fayetteville is served by commuter lines for several major airlines as follows: American Eagle, connecting in Dallas, Texas; Braniff Airlines, connecting in Kansas City, Kansas; Delta Connection, connecting in Dallas, Texas;

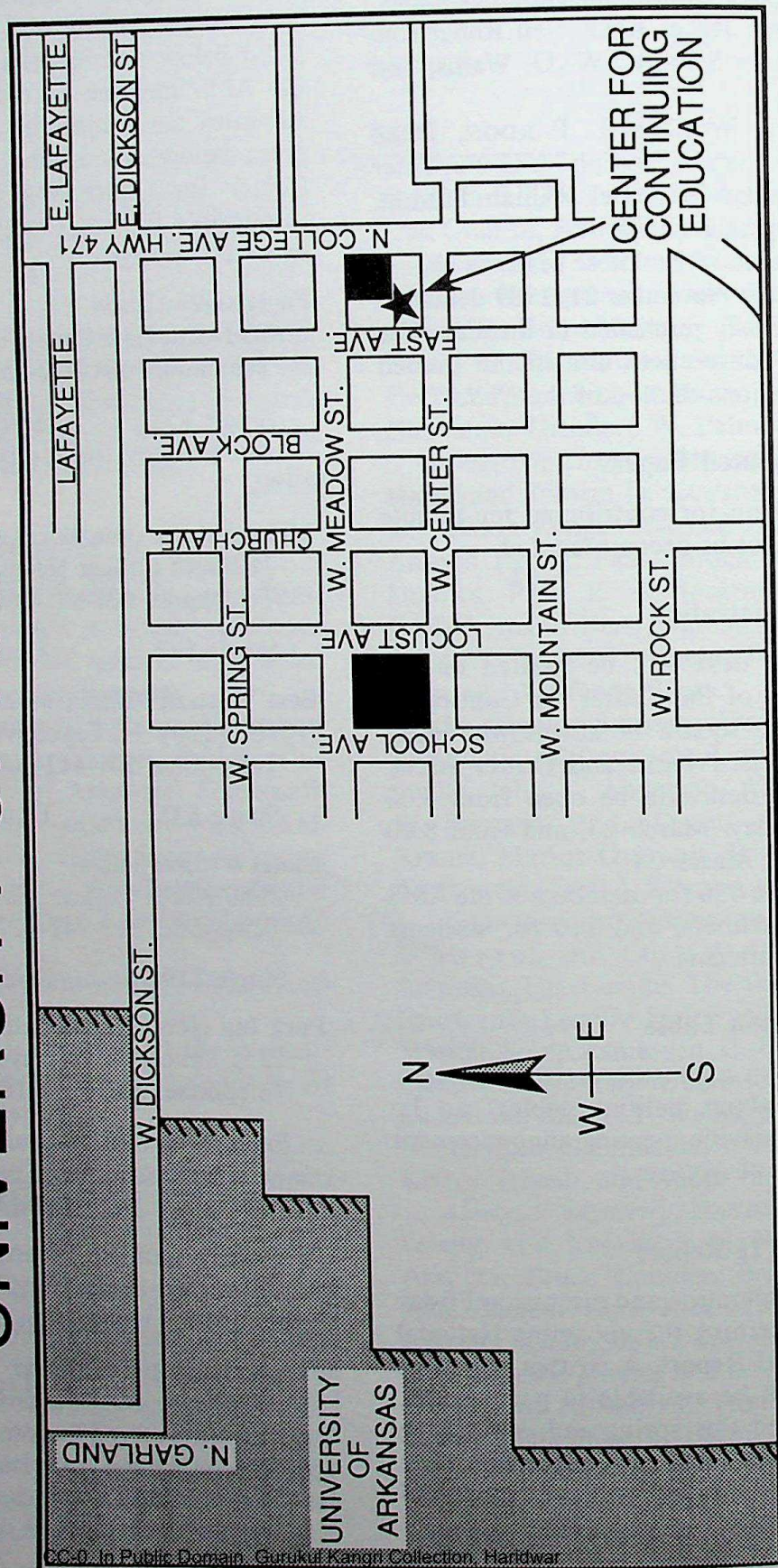
Northwest Airlink, connecting in Memphis, Tennessee; and Trans World Express, connecting in St. Louis, Missouri. The Best Western Inn, Fayetteville Hilton, and Mountain Inn have complimentary van service to and from the airport. Taxi service is also available. The

Fayetteville Airport is approximately four miles from center of town.

Weather

The weather in late March is usually mild though occasionally rainy.

UNIVERSITY OF ARKANSAS



Program of the Sessions

The time limit for each contributed paper in the sessions is ten minutes. In the special sessions, the time limit varies from session to session and within sessions. To maintain the schedule, time limits will be strictly enforced.

Abstracts of papers presented in the sessions at this meeting will be found in the March 1990 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.

Friday, March 23

Special Session on Banach Algebras, I

8:00 a.m.–10:55 a.m.

Room 411, Center for Continuing Education

- 8:00 a.m. *Spectral theory in F -algebras with applications to*
(1) *Laplace transforms.*
Bruce Barnes, University of Oregon (856-46-75)
- 8:30 a.m. *A characterization of operator algebras and*
(2) *applications.*
David P. Blecher, University of Houston, Houston (856-46-82)
- 9:00 a.m. *Standard homomorphisms and regulated weights on*
(3) *weighted convolution algebras.*
F. Ghahramani*, **J. P. McClure**, University of Manitoba, and **S. Grabiner**, Pomona College (856-46-10)
- 9:30 a.m. *Convergent sequences and standard ideals in*
(4) *weighted convolution algebras.* Preliminary report.
Sandy Grabiner, Pomona College (856-46-11)
- 10:00 a.m. Informal Discussion

Special Session on Complex Function Theory of One and Several Variables, I

8:00 a.m.–10:30 a.m.

Room 402, Center for Continuing Education

- 8:00 a.m. *Removable singularities for L^1CR functions.*
(5) Preliminary report.
John T. Anderson*, College of the Holy Cross, and **Joseph A. Cima**, University of North Carolina, Chapel Hill (856-32-115)
- 8:40 a.m. *Some results related to Landau's covering theorem.*
(6) **Albert Baernstein, II**, Washington University (856-30-40)
- 9:20 a.m. *Some open problems in one and several complex*
(7) *variables.*
Roger W. Barnard, Texas Tech University (856-30-84)

10:00 a.m. *Sets lying over the sphere in C^2 .* Preliminary report.
(8) **John Wermer**, Brown University (856-32-79)

Special Session on Phase-type Distributions and Some Applications, I

8:00 a.m.–10:30 a.m.

Room 107, Center for Continuing Education

- 8:00 a.m. *New results on the single server queue with a batch*
(9) *Markovian arrival process.*
David M. Lucantoni, AT&T Bell Laboratories, Holmdel, New Jersey (856-90-24) (Sponsored by Itrel E. Monroe)
- 8:40 a.m. *Phase-type representation of waiting times.*
(10) **Soren Asmussen**, Chalmers Institute of Technology, Sweden (856-90-26) (Sponsored by Itrel E. Monroe)
- 9:30 a.m. *Phase-distribution selection methods: Recent*
(11) *developments.*
Mary A. Johnson, University of Arizona (856-90-25) (Sponsored by Itrel E. Monroe)
- 10:00 a.m. *Implementation of matrix analytic methods for phase*
(12) *type queues using uniformization techniques.*
V. Ramaswami, Bell Communications Research, Morristown, New Jersey (856-90-21) (Sponsored by Itrel E. Monroe)

Special Session on Geometry, Physics and Nonlinear PDE's, I

8:00 a.m.–10:50 a.m.

Room 204, Center for Continuing Education

- 8:00 a.m. *Maximum principles and applications.* Preliminary
(13) report.
I. Bakelman, Texas A & M University, College Station (856-35-72)
- 8:35 a.m. *A survey of some unusual harmonic maps from the*
(14) *3-ball to the 2-sphere.* Preliminary report.
Robert Hardt, Rice University (856-49-67)
- 9:10 a.m. *Spherical minimal immersions of spherical space*
(15) *forms.* Preliminary report.
Dennis DeTurck, University of Pennsylvania (856-53-77)

Friday, March 23 (cont'd)

9:45 a.m. *The changing geometry of isospectral manifolds.*
(16) **Dennis DeTurck, Herman Gluck**, University of Pennsylvania, **Carolyn Gordon*** and **David Webb**, Washington University (856-53-30)

10:20 a.m. *On the index of the Costa-Hoffan-Meeks minimal surface.* Preliminary report.
(17) **Peter Li**, University of Arizona, **Luen-Fai Tam**, The Chinese University of Hong Kong, Hong Kong, **Frank Stenger** and **Andrejs E. Treibergs***, University of Utah (856-53-52)

Special Session on Combinatorics, I

8:00 a.m.-9:50 a.m. Room 405, Center for Continuing Education

8:00 a.m. *Finite descriptions of tree ideals.* Preliminary report.
(18) **Neil Robertson***, Ohio State University, Columbus, **P. D. Seymour**, Bell Communication Research, and **Robin Thomas**, Georgia Institute of Technology (856-05-125)

8:40 a.m. *An included minor result for 3-connected graphs.*
(19) Preliminary report.
Bogdan Oporowski* and **James Oxley**, Louisiana State University, Baton Rouge (856-05-32)

9:20 a.m. *A characterization of the planar graphs with no 6-wheel minor.* Preliminary report.
(20) **Bradley S. Gubser**, Louisiana State University, Baton Rouge (856-05-98)

Session on Banach Lattices and Theory of Determinates

9:00 a.m.-9:30 a.m. Room 406, Center for Continuing Education

9:00 a.m. *Sums of homomorphisms into Dedekind complete Banach lattices.*
(21) **David C. Carothers***, Hope College, and **William A. Feldman**, University of Arkansas, Fayetteville (856-47-127)

9:20 a.m. *The value of certain determinants with elements ± 1 .*
(22) Preliminary report.
Dale Woods* and **D. J. Boyce**, Central State University (856-15-100)

Invited Address

11:00 a.m.-noon

Room 107, Center for Continuing Education

(23) *Phase-type distributions: Basic properties.*
Marcel F. Neuts, University of Arizona (856-90-16)
(Sponsored by Itrel E. Monroe)

Invited Address

1:00 p.m.-2:00 p.m.

Room 204, Center for Continuing Education

(24) *Selected nonlinear problems in geometry.*
Vladimir I. Oliker, Emory University (856-53-50)

Special Session on Banach Algebras, II

2:10 p.m.-4:35 p.m.

Room 411, Center for Continuing Education

2:10 p.m. *Multipliers of weighted L^p spaces.*
(25) **Peter A. Detre**, Southwest Missouri State University (856-47-36)

2:40 p.m. *Compact endomorphisms of Banach algebras.*
(26) **Herbert Kamowitz**, University of Massachusetts, Boston (856-46-112)

3:10 p.m. *Semi-simple Banach algebras and super-decomposable operators.* Preliminary report.
(27) **Michael M. Neumann**, Mississippi State University (856-47-128)

3:40 p.m. Informal Discussion

Special Session on Semigroups in Geometry and Analysis, I

2:10 p.m.-6:00 p.m.

Room 409, Center for Continuing Education

2:10 p.m. *The duality between subsemigroups of Lie groups and monotone functions.*
(28) **Karl-Hermann Neeb**, Technische Hochschule Darmstadt, Federal Republic of Germany (856-22-07)
(Sponsored by Karl H. Hofmann)

2:50 p.m. *On the geometry of subsemigroups of Lie groups.*
(29) **Wolfgang A. F. Ruppert**, Universität für Bodenkultur Austria and Technische Hochschule Darmstadt, Federal Republic of Germany (856-22-02)
(Sponsored by Karl H. Hofmann)

3:30 p.m. *On the set of compact subgroups of a locally compact group.*
(30) **Christian Terp**, Technische Hochschule Darmstadt, Federal Republic of Germany (856-22-03)
(Sponsored by Karl H. Hofmann)

- 4:10 p.m. (31) *On topological semigroups of conal curves and connecting homotopy.*
Wolfgang Weiss, Technische Hochschule Darmstadt, Federal Republic of Germany (856-22-08)
(Sponsored by Karl H. Hofmann)
- 4:50 p.m. (32) *Causality and homothetic maps on space-time.*
Paul Ehrlich, University of Florida (856-53-15)
- 5:30 p.m. (33) *Applications of differentiable semigroups in operator theory.*
J. P. Holmes, Auburn University, Auburn (856-20-39)

Special Session on Complex Function Theory of One and Several Variables, II

2:10 p.m.-4:00 p.m. Room 402, Center for Continuing Education

- 2:10 p.m. (34) *Robin functions and energy functionals of multiply connected domains.*
P. L. Duren*, University of Michigan, Ann Arbor, and **M. M. Schiffer**, Stanford University (856-30-65)
- 2:50 p.m. (35) *Schwarzian derivatives and zeros of solutions of second order linear differential equations.*
A. Hinkkanen*, University of Texas, Austin, and **John Rossi**, Virginia Polytechnic Institute and State University (856-30-92)
- 3:30 p.m. (36) *Harmonic analysis on domains.*
Steven G. Krantz, Washington University (856-42-27)

Special Session on Phase-type Distributions and Some Applications, II

2:10 p.m.-5:10 p.m. Room 107, Center for Continuing Education

- 2:10 p.m. (37) *Phase-type distributions: Use in queuing models.*
Marcel F. Neuts, University of Arizona (856-90-17)
(Sponsored by Irel E. Monroe)
- 3:10 p.m. (38) *A finite capacity polling system with non-exhaustive service and non-renewal input.*
C. Blondia, Philips Research Laboratory, Belgium (856-90-47) (Sponsored by Irel E. Monroe)
- 3:50 p.m. (39) *ML estimation of the parameters of a PH-distribution in triangular canonical form.*
Andrea Bobbio* and **Aldo Cumani**, Istituto Elettrotecnico Nazionale Galileo Ferraris, Italy (856-90-48) (Sponsored by Irel E. Monroe)
- 4:30 p.m. Informal Discussion

Special Session on Geometry, Physics and Nonlinear PDE's, II

2:10 p.m.-7:20 p.m. Room 204, Center for Continuing Education

- 2:10 p.m. (40) *Null directions and curvature.* Preliminary report.
John K. Beem*, University of Missouri, Columbia, and **Phillip E. Parker**, Wichita State University (856-53-53)
- 2:45 p.m. (41) *Index, vision number and stability of complete minimal surfaces.* Preliminary report.
Jaigyoung Choe, Rice University (856-53-56)
(Sponsored by Andrejs E. Treibergs)
- 3:20 p.m. (42) *Causal and geodesic behavior of gravitational plane waves.*
P. Ehrlich*, **G. Emch**, University of Florida, and **G. Galloway**, University of Miami (856-53-13)
- 3:55 p.m. (43) *Worn stones - a second look.* Preliminary report.
Wm. J. Firey, Oregon State University (856-52-45)
- 4:30 p.m. (44) *Contact Riemannian three-manifolds.* Preliminary report.
Samuel I. Goldberg, University of Illinois, Urbana-Champaign (856-53-71)
- 5:05 p.m. (45) *The inhomogeneous extremal metric problem for closed surfaces.*
Eugenio Calabi, University of Pennsylvania (856-53-68)
- 5:40 p.m. (46) *Almost umbilic submanifolds.* Preliminary report.
R. Howard, University of South Carolina, Columbia (856-53-58)
- 6:15 p.m. (47) *Domains in Riemannian manifolds and inverse spectral geometry.*
Harold Donnelly and **Jeffrey Lee***, Purdue University, West Lafayette (856-53-55)
- 6:50 p.m. (48) *On the size of the blowup set for a quasilinear parabolic equation.*
Michael E. Gage, University of Rochester (856-35-54)

Special Session on Combinatorics, II

2:10 p.m.-4:00 p.m. Room 405, Center for Continuing Education

- 2:10 p.m. (49) *Bounds for rectilinear crossing numbers.*
Daniel Bienstock and **Nathaniel Dean***, Bellcore, Morristown, New Jersey (856-05-44)
- 2:50 p.m. (50) *Generalized total colorings.*
Hugh Hind, University of Southern Mississippi (856-05-126)
- 3:30 p.m. (51) *Coclosure operators and chromatic polynomials.*
Nigel Ray, University of Manchester, England, and **William Schmitt***, Memphis State University (856-05-34)

Friday, March 23 (cont'd)

Special Session on Differential Geometry, I

2:10 p.m.-4:20 p.m. Room 404, Center for Continuing Education

- 2:10 p.m. $(-1/4)$ -pinched Riemannian metrics on compact
(52) Kaehler manifolds.
Fangyang Zheng, Massachusetts Institute of Technology (856-53-120)
- 2:55 p.m. L_2 - $\bar{\partial}$ -cohomology of projective varieties.
(53) **William Pardon*** and **Mark Stern**, Duke University (856-58-118)
- 3:40 p.m. Kähler-Einstein metrics of positive scalar curvature.
(54) **Alan M. Nadel**, Massachusetts Institute of Technology (856-32-86)

Special Session on Singular Integral Operators and Related Areas, I

2:10 p.m.-6:00 p.m. Room 403, Center for Continuing Education

- 2:10 p.m. Continuity properties of pseudodifferential operators
(55) and other operators with singular kernels.
Rodolfo H. Torres, Washington University (856-35-89)
- 2:50 p.m. Weighted inequalities for averaging operators.
(56) **Kenneth F. Andersen**, University of Alberta (856-42-63)
- 3:30 p.m. Oscillatory integrals with polynomial phase.
(57) Preliminary report.
Dan Oberlin, Florida State University (856-42-64)
- 4:10 p.m. On the approximation problem for $\bar{\partial}^2$. Preliminary
(58) report.
James L. Wang, University of Alabama, Tuscaloosa (856-30-80)
- 4:50 p.m. Projection theorems for estimating harmonic measure.
(59) **Peter M. Knopf**, Pace University (856-32-123)
- 5:30 p.m. Estimates for the maximal operator of the
(60) Ornstein-Uhlenbeck semigroup. Preliminary report.
Cristian E. Gutiérrez*, Temple University, Philadelphia, and **Wilfredo O. Urbina**, Universidad Central de Venezuela, Caracas (856-42-113)

Saturday, March 24

Special Session on Banach Algebras, III

8:00 a.m.-10:30 a.m. Room 411, Center for Continuing Education

- 8:00 a.m. Remarks on the approximation property.
(61) **P. G. Casazza** and **N. J. Kalton***, University of Missouri, Columbia (856-46-38)
- 8:40 a.m. The second conjugate algebra of $L_1(G)$ of a locally
(62) compact group.
Anthony To-Ming Lau, University of Alberta (856-43-102)
- 9:20 a.m. Spectral algebras.
(63) **Theodore W. Palmer**, University of Oregon (856-46-91)
- 10:00 a.m. Decompositions of commutative Banach algebras as
(64) semi-direct products and other structure results. Preliminary report.
Marc P. Thomas, California State University, Bakersfield (856-46-09)

Special Session on Semigroups in Geometry and Analysis, II

8:00 a.m.-10:30 a.m. Room 409, Center for Continuing Education

- 8:00 a.m. Positive definite and negative definite functions on the
(65) Heisenberg group.
Palle E. T. Jorgensen, University of Iowa (856-47-01)
- 8:40 a.m. On the semigroup $(\exp iW)G$. Preliminary report.
(66) **Norbert Dörr**, Technische Hochschule Darmstadt, Federal Republic of Germany (856-22-06) (Sponsored by Karl H. Hofmann)
- 9:20 a.m. Classification of Lie semialgebras. Preliminary report.
(67) **Anselm Eggert**, Technische Hochschule Darmstadt, Federal Republic of Germany (856-22-04) (Sponsored by Karl H. Hofmann)
- 10:00 a.m. Classification of hyperplane subalgebras in real Lie
(68) algebras, *Geometriae Dedicata* 1990, to appear.
Karl H. Hofmann, Technische Hochschule Darmstadt, Federal Republic of Germany (856-22-05)

Special Session on Complex Function Theory of One and Several Variables, III

8:00 a.m.-10:30 a.m. Room 402, Center for Continuing Education

- 8:00 a.m. The minimum points of the hyperbolic metric in plane
(69) domains.
Marius Overholt, University of Tennessee, Knoxville (856-30-103)

- 8:40 a.m. *Calderon Toeplitz operators*. Preliminary report.
 (70) **Krzysztof Nowak** and **Richard Rochberg***,
 Washington University (856-46-101)
- 9:20 a.m. *Polynomial hulls and analytic motions*.
 (71) **Zbigniew Słodkowski**, University of Illinois, Chicago
 (856-32-85) (Sponsored by Dima Khavinson)
- 10:00 a.m. *Equivalence of regularity for the Bergman projection
 and the $\bar{\partial}$ -Neumann operator*.
 (72) **Harold P. Boas** and **Emil J. Straube***, Texas A & M
 University, College Station (856-32-94)

Special Session on Phase-type Distributions and Some Applications, III

8:00 a.m.-10:50 a.m. Room 107, Center for
 Continuing Education

- 8:00 a.m. *Observable and unobservable aspects of Markov
 models*.
 (73) **Colm O'Cinneide**, Louisiana State University, Baton
 Rouge (856-90-23) (Sponsored by Itrel E. Monroe)
- 8:40 a.m. *On multivariate phase type distributions*.
 (74) **Ushio Sumita**, University of Rochester (856-90-22)
 (Sponsored by Itrel E. Monroe)
- 9:20 a.m. *Computer solution of stochastic models*.
 (75) **Kishor Trivedi**, Duke University (856-90-20)
 (Sponsored by Itrel E. Monroe)
- 10:00 a.m. *Phase-type distributions: In the construction of point
 processes*.
 (76) **Marcel F. Neuts**, University of Arizona (856-90-18)
 (Sponsored by Itrel E. Monroe)

Special Session on Geometry, Physics and Nonlinear PDE's, III

8:00 a.m.-10:50 a.m. Room 204, Center for
 Continuing Education

- 8:00 a.m. *Conformal deformation of metrics to constant mean
 curvature*.
 (77) **José F. Escobar**, University of Chicago (856-53-31)
- 8:35 a.m. *Riemannian metrics on fiber bundles*. Preliminary
 report.
 (78) **Gary R. Jensen***, Washington University, and **Marco
 Rigoli**, Citta Universitaria, Italy (856-53-33)
- 9:10 a.m. *On the structure of complete embedded constant
 mean curvature surfaces in Euclidean space*.
 Preliminary report.
 (79) **Nicholas J. Korevaar**, University of Utah (856-53-57)
- 9:45 a.m. *Conformal deformation equation and isospectral set of
 conformal metrics*. Preliminary report.
 (80) **Sun-Yung A. Chang**, University of California, Los
 Angeles, and **Paul C. Yang***, University of Southern
 California (856-53-59)
- 10:20 a.m. *Rotational mean curvature flow, quenching and blow
 up*.
 (81) **Bernhard Kawohl**, Universität Heidelberg, Federal
 Republic of Germany (856-35-35)

Special Session on Combinatorics, III

8:00 a.m.-9:50 a.m. Room 405, Center for Continuing
 Education

- 8:00 a.m. *Matchings in regular graphs*.
 (82) **M. D. Plummer**, Vanderbilt University (856-05-62)
- 8:40 a.m. *The maximum value of the principal eigenvalue of a
 planar graph*. Preliminary report.
 (83) **B. N. Boots**, Wilfrid Laurier University, and **Gordon F.
 Royle***, Vanderbilt University (856-05-88)
- 9:20 a.m. *On quasi-threshold graphs*.
 (84) **W. D. Wallis**, Southern Illinois University, Carbondale
 (856-05-42)

Special Session on Singular Integral Operators and Related Areas, II

8:00 a.m.-10:30 a.m. Room 403, Center for
 Continuing Education

- 8:00 a.m. *Bounded point evaluations*. Preliminary report.
 (85) **Tavan T. Trent**, University of Alabama, Tuscaloosa
 (856-47-81)
- 8:40 a.m. *Cauchy integrals on terrible curves*.
 (86) **J. Michael Wilson**, University of Vermont (856-42-74)
- 9:20 a.m. *Littlewood-Paley theory on spaces of homogenous
 type*.
 (87) **Björn Jawerth**, University of South Carolina,
 Columbia (856-46-121)
- 10:00 a.m. *Singular integral operators and Hardy spaces*.
 (88) **John Gilbert**, University of Texas, Austin (856-42-46)
 (Sponsored by R. E. Showalter)

Special Session on Algebraic Geometry, I

8:30 a.m.-10:50 a.m. Room 410, Center for
 Continuing Education

- 8:30 a.m. *The Hodge decomposition for smooth quasi-projective
 varieties*.
 (89) **Donu Arapura**, Purdue University, West Lafayette
 (856-14-105)
- 9:00 a.m. *Obstructions for deformations of singularities*.
 Preliminary report.
 (90) **Jan Stevens**, University of Utah (856-32-97)
- 9:30 a.m. *The Artin smoothing problem and the approximation
 theorems*. Preliminary report.
 (91) **Mark Spivakovsky**, Harvard University (856-13-119)
- 10:00 a.m. *The structure of small resolutions*. Preliminary report.
 (92) **Sheldon Katz**, Oklahoma State University, Stillwater,
 and **David R. Morrison***, Duke University (856-14-90)
- 10:30 a.m. *Donaldson's polynomials of surfaces in P^3* .
 Preliminary report.
 (93) **Kieran O'Grady**, Columbia University (856-14-95)

Saturday, March 24 (cont'd)

Invited Address

11:00 a.m. - noon

Room 204, Center for Continuing Education

- (94) *A geometric trace formula for Hecke operators.*
Mark A. Stern, Institute for Advanced Study
 (856-58-51)

Invited Address

1:00 p.m. - 2:00 p.m.

Room 204, Center for Continuing Education

- (95) *Topology and geometry of isolated complex surface singularities.*
Jonathan Wahl, University of North Carolina, Chapel Hill (856-14-122)

Special Session on Semigroups in Geometry and Analysis, III

2:10 p.m. - 5:20 p.m.

Room 409, Center for Continuing Education

- 2:10 p.m. *Product integrals in differentiable groupoids with multiplication strongly differentiable at the identity.* Preliminary report.
 (96) **Mitchell J. Anderson**, University of Hawaii, Hilo (856-22-106)
- 2:50 p.m. *Compact uniquely divisible matrix semigroups.*
 (97) **Dennison R. Brown** and **James W. Stepp***, University of Houston, Houston (856-22-99)
- 3:30 p.m. *The lattice of principal ideals of a linear algebraic monoid.*
 (98) **Mohan S. Putcha**, North Carolina State University (856-20-87) (Sponsored by Jimmie D. Lawson)
- 4:10 p.m. *Infinitesimal bisimple bases and transitive representations of inverse semigroups.* Preliminary report.
 (99) **Boris M. Schein**, University of Arkansas, Fayetteville (856-20-107)
- 4:50 p.m. *Multiplicative semigroups of infinite dimensional matrices.* Preliminary report.
 (100) **Arunava Mukherjea**, University of South Florida (856-15-73)

Special Session on Phase-type Distributions and Some Applications, IV

2:10 p.m. - 5:00 p.m.

Room 107, Center for Continuing Education

- 2:10 p.m. *A finite capacity dynamic priority queueing model with phase type services.*
 (101) **S. Chakravarthy**, GMI Engineering and Management Institute, Flint, Michigan (856-90-49) (Sponsored by Itrel E. Monroe)
- 2:50 p.m. *Must matrix representations of distributions be restricted to phase type?*
 (102) **Lester Lipsky**, University of Connecticut, Storrs (856-90-108) (Sponsored by Itrel E. Monroe)
- 3:30 p.m. *The moment problem for continuous distributions.* Preliminary report.
 (103) **Appie van de Liefvoort**, University of Missouri, Kansas City (856-90-109) (Sponsored by Thomas P. Kezlan)
- 4:10 p.m. *Phase-type distributions: Asymptotic results.*
 (104) **Marcel F. Neuts**, University of Arizona (856-90-19) (Sponsored by Itrel E. Monroe)

Special Session on Geometry, Physics and Nonlinear PDE's, IV

2:10 p.m. - 7:20 p.m.

Room 204, Center for Continuing Education

- 2:10 p.m. *On the parabolic harmonic map equation from non-compact manifolds.*
 (105) **G. Liao***, University of Texas, Arlington, and **L. F. Tam**, The Chinese University of Hong Kong, Hong Kong (856-53-78)
- 2:45 p.m. *Generalized convex hypersurfaces.*
 (106) **Erwin Lutwak**, Polytechnic University of New York (856-52-60)
- 3:20 p.m. *Prescribed curvature and singularities of conformal metrics on Riemann surfaces.* Preliminary report.
 (107) **Robert C. McOwen**, Northeastern University (856-35-61)
- 3:55 p.m. *A priori estimates for a class of problems from nonlinear elasticity.* Preliminary report.
 (108) **Patricia Bauman**, Purdue University, West Lafayette; **Nicholas Owen**, University of Bath, United Kingdom; and **Daniel Phillips***, Purdue University, West Lafayette (856-35-28)
- 4:30 p.m. *The local structure of Riemannian manifolds.* Preliminary report.
 (109) **Patrick Ghanaat**, Swiss Federal Institute of Technology, Switzerland; **Maung Min-oo**, McMaster University; and **Ernst A. Ruh***, Ohio State University, Columbus (856-53-37)
- 5:05 p.m. *Darboux mappings and locally convex surfaces.* Preliminary report.
 (110) **Friedmar Schulz**, University of Iowa (856-35-12)

- 5:40 p.m. *A class of nonlinear partial differential systems with geometric applications.*
(111) **S. Walter Wei**, University of Oklahoma (856-53-69)
- 6:15 p.m. *Surfaces of constant mean curvature of Enneper type.*
(112) **Henry C. Wente**, University of Toledo (856-53-76)
- 6:50 p.m. *A geometric estimate for the index of an umbilic on a smooth surface.*
(113) **Frederico Xavier**, University of Notre Dame (856-53-14)

Special Session on Combinatorics, IV

2:10 p.m.-4:40 p.m. Room 405, Center for Continuing Education

- 2:10 p.m. *On integrity of matroids. Preliminary report.*
(114) **Safwan Akkari**, Indiana University-Purdue University, Fort Wayne (856-05-43)
- 2:50 p.m. *The binary matroids having an element in every 4-wheel minor. Preliminary report.*
(115) **Talmage James Reid**, University of Mississippi (856-05-111)
- 3:30 p.m. *On minors avoiding elements in matroids.*
(116) **James G. Oxley**, Louisiana State University, Baton Rouge (856-05-83)
- 4:10 p.m. *On the intersection rank of strongly regular graphs.*
(117) **James A. Wiseman**, Southern Illinois University, Carbondale (856-05-124) (Sponsored by Walter D. Wallis)

Special Session on Algebraic Geometry, II

2:15 p.m.-5:05 p.m. Room 410, Center for Continuing Education

- 2:15 p.m. *Orbits of the action of $PGL(3)$ on spaces of plane curves.*
(118) **Paolo Aluffi**, Oklahoma State University, Stillwater (856-14-104)
- 2:45 p.m. *Birational mappings between hypersurfaces of degree M in P^M .*
(119) **Bruce Crauder**, Oklahoma State University, Stillwater (856-14-93)

- 3:15 p.m. *Cremona transformations and syzygies.*
(120) **Sheldon Katz***, Oklahoma State University, Stillwater, **Klaus Hulek** and **Frank Schreyer**, Universitaet Bayreuth, Federal Republic of Germany (856-14-96)
- 3:45 p.m. *Hilbert functions of points in good position in P^2 .*
(121) **Brian Harbourne**, University of Nebraska, Lincoln (856-14-110)
- 4:15 p.m. *On set-theoretic complete intersections in complex projective space.*
(122) **David B. Jaffe**, University of Nebraska, Lincoln (856-14-66)
- 4:45 p.m. *Some recent results on the Gaussian map for curves.*
(123) Preliminary report.
Rick Miranda, Colorado State University (856-14-116)

Special Session on Differential Geometry, II

2:15 p.m.-5:10 p.m. Room 404, Center for Continuing Education

- 2:15 p.m. *Index theory on homogeneous spaces.*
(124) **Jeffrey Fox**, University of Colorado, Boulder, and **Peter Haskell***, Virginia Polytechnic Institute and State University (856-46-41)
- 3:00 p.m. *Curvature measures of subanalytic sets.*
(125) **Joseph H. G. Fu**, Indiana University, Bloomington (856-32-29)
- 3:45 p.m. *Some aspects of analysis on locally symmetric spaces of finite volume.*
(126) **Werner Muller**, Institute for Advanced Study (856-53-114) (Sponsored by Mark A. Stern)
- 4:30 p.m. *Results of integrality of characteristic numbers.*
(127) **Sai Kee Yeung**, Massachusetts Institute of Technology (856-53-117)

Joseph A. Cima
Associate Secretary
Chapel Hill, North Carolina

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University Park Pennsylvania State University April 7 – 8

Second Announcement

The eight-hundred-and-fifty-seventh meeting of the American Mathematical Society will be held at the Pennsylvania State University in University Park, Pennsylvania, on Saturday, April 7, and Sunday, April 8, 1990. This meeting will be held in conjunction with a meeting of the Association for Symbolic Logic (ASL).

Invited Addresses

By invitation of the Eastern Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks where available, and the scheduled times of presentation are:

ROBERT T. GLASSEY, Indiana University, *Collisionless plasmas and the Vlasov-Maxwell equations*, 11:00 a.m. Sunday.

KARSTEN GROVE, University of Maryland, College Park, *Geometry and topology of manifolds curved from below*, 1:30 p.m. Sunday.

LOWELL EDWIN JONES, State University of New York at Stony Brook, *Topological rigidity for manifolds of non-positive curvature*, 11:00 a.m. Saturday.

GANG TIAN, Princeton University, *Einstein metrics on algebraic manifolds*, 1:30 p.m. Saturday.

Special Sessions

By invitation of the same committee, there will be four special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Classical and quantum groups, RANEE KATHRYN BRYLINSKI, Pennsylvania State University.

Algebraic topology, DONALD M. DAVIS, Lehigh University.

Geometric topology, THOMAS FARRELL, Columbia University.

Recent progress on Einstein manifolds and related topics, GANG TIAN.

Abstracts for consideration for these sessions should have been submitted by the **January 4, 1990** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited

Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Late papers will not be accommodated.

Registration

The meeting registration desk will be located in the lobby of the Keller Conference Center. The registration fees are \$30 for members of the AMS or ASL, \$45 for nonmembers, and \$10 for students and unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

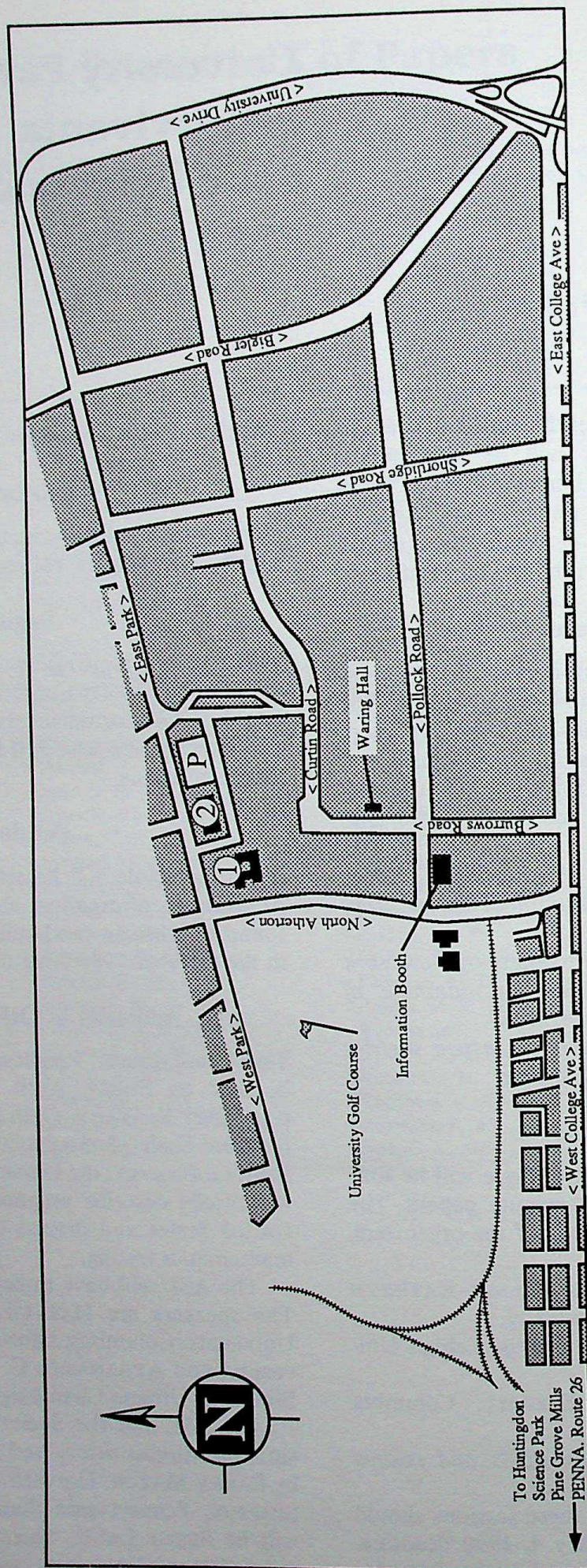
Activities of Other Organizations

The **Pennsylvania Prognostic Testing Conference** will be held on Friday, April 6, from 1:30 p.m. to 4:30 p.m. BERT K. WAITS, Ohio State University, will discuss the *Ohio Early Mathematics Placement Testing Program*. JOHN G. HARVEY, the University of Wisconsin, Madison, will briefly describe prognostic testing programs in the United States and discuss the effects of calculators on mathematics testing.

The ASL will have three invited one-hour addresses. The speakers are HARVEY M. FRIEDMAN, Ohio State University, Columbus; LEONARD LIPSCHITZ, Purdue University; and ATHANASIOS C. PHEIDAS, the University of Illinois at Urbana-Champaign.

The ASL and the Society will co-sponsor a symposium on *Number theory and decidability* to be moderated by BARRY MAZUR, Harvard University, and STEPHEN G. SIMPSON, Pennsylvania State University. The panelists will be SERGE LANG, Yale University, ANGUS MACINTYRE, Oxford University, and LOU VAN DEN DRIES, the University of Illinois, Urbana.

PENNSYLVANIA STATE UNIVERSITY



1 – Nittany Lion Inn 2 – Conference Center P – Parking

Social Event

A wine and beer reception will be held Saturday evening, April 7, from 5:00 p.m. to 7:30 p.m. in the Fireside Lounge at the Nittany Lion Inn. The admission price is \$5 per person.

Accommodations

A block of rooms has been reserved at each of the following hotels/motels. The American Mathematical Society is not responsible for rate changes or accommodations offered by hotels/motels.

Nittany Lion Inn

North Atherton Street,
University Park, PA 16802
Telephone: 814-231-7500

Single \$58 Double \$68

Hampton Inn

East College Avenue,
University Park, PA 16802
Telephone: 814-231-1590

Single \$46 Double \$50

Sheraton/Days Inn

South Street,
University Park, PA 16802
Telephone: 814-238-8454

Single \$53 Double \$63

Food Service

The Nittany Lion Inn, adjacent to the Keller Conference Center, has a full service restaurant offering breakfast, lunch, and dinner. Complete listings will be available at the meeting registration desk.

Travel

US Air/Allegheny Commuter Airlines serve the State College area through the University Park Airport located five miles from campus. Limousine or taxi service is available for all flights. For reservations and information on US Air/Allegheny Commuter, please call 814-238-8414 or 800-428-4253. By bus, Trailways and Greyhound Lines connections are available to and from State College. For Trailways information please call 814-238-7362; for Greyhound information please call 814-237-5865. If traveling by car, University Park is readily accessible from both ends of the state via Interstate 80 (I-80).

Parking

Parking is available on campus for a fee of \$3 per day.

W. Wistar Comfort

Associate Secretary

Middletown, Connecticut

UNIMODAL LOG-CONCAVE AND PÓLYA FREQUENCY SEQUENCES IN COMBINATORICS

Francesco Brenti

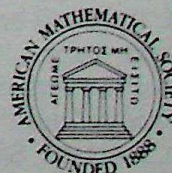
(Memoirs of the AMS, Number 413)

In recent years, considerable research has focused on unimodal or log-concave sequences that are of combinatorial interest. Although these two properties have simple definitions, proving that a sequence is unimodal or log-concave is often a difficult task requiring refined and sophisticated mathematical tools from such areas as representation theory, algebraic geometry, or classical analysis.

The main purpose of this book is to show the theory of total positivity can be very useful in studying this area. In the first part of the book, after discussing some combinatorial motivations, the author studies some of the fundamental linear transformations that preserve the log-concavity or Pólya frequency properties of a sequence. This part forms the theoretical core of the work and may be read independently from the rest. In fact, this rich and powerful theory can be

applied to any situation in which log-concavity and unimodality questions arise. The second part of the book is devoted to applications to several combinatorial situations, yielding many new results and solutions to some problems that had resisted attack with other techniques. Both parts of the book point to many conjectures, open problems, and directions for further study.

1980 *Mathematics Subject Classifications*: 05A20; 05A15, 05A10, 05C20, 06A10, 11B73, 15A04, 26C10, 30C15
ISBN 0-8218-2476-7, LC 89-15137
ISSN 0065-9266
106 pages (softcover), September 1989
Individual member \$10, List price \$17.
Institutional member \$14
To order, please specify MEMO/413NA



All prices subject to change. Shipment will be made by surface. For air delivery add, 1st book \$5, each additional book \$3, maximum \$100. Prepayment required. Order from American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS (321-4267) in the U.S. and Canada to charge with VISA or MasterCard.

Albuquerque, New Mexico

University of New Mexico

April 19–21

Second Announcement

The eight-hundred-and-fifty-eighth meeting of the American Mathematical Society will be held at the Sheraton Old Town Hotel in Albuquerque, New Mexico, on Thursday, April 19, Friday, April 20, and Saturday, April 21, 1990. This meeting is being held in cooperation with the Society for Industrial and Applied Mathematics (SIAM) and being hosted by the University of New Mexico.

Invited Addresses

By invitation of the Far Western Section Program Committee, and in cooperation with SIAM, there will be six invited one-hour addresses. The speakers, their affiliations, and the titles of their talks where available are:

DAVID CAMPBELL, Los Alamos National Laboratory, *Solitary waves and their interactions in non-integrable nonlinear partial differential equations.*

PETER B. GILKEY, University of Oregon, *Can one hear the shape of a drum?*

GUNDORPH K. KRISTIANSEN, Lund University, *Recent developments in time-domain inverse scattering theory using invariant embedding techniques.*

ROBERT MAY, Oxford University, *title to be announced.*

ALAN NEWELL, University of Arizona, *Convection patterns in large containers.*

MARC A. RIEFFEL, University of California, Berkeley, *Quantum groups and operator algebras.*

Special Sessions

By invitation of the same committee, and in cooperation with SIAM, there will be seven special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Numerical solution of partial differential equations, RICHARD C. ALLEN, Sandia National Laboratory, JOSÉ CASTILLO, San Diego State University, and STANLY STEINBERG, University of New Mexico.

Geometry and topology of moduli spaces, CHARLES P. BOYER, and BENJAMIN M. MANN, University of New

Mexico.

Real algebraic geometry, MICHAEL A. BUCHNER, University of New Mexico, and WOJCIECH KUCHARZ, University of Hawaii and University of New Mexico.

Dynamical systems: low dimensional behavior in partial differential equations, DAVID CAMPBELL, and JAMES M. HYMAN, Los Alamos National Laboratory.

Invariant embedding and inverse problems, JAMES CORONES, Ames Laboratory, PAUL NELSON, Texas A&M, and DANIEL SETH, Ames Laboratory.

Differential geometry, HOWARD FEGAN and ALEXANDER P. STONE, University of New Mexico.

Mathematical Biology, JAMES M. HYMAN, Los Alamos National Laboratory, W. T. KYNER, University of New Mexico, ANN STANLEY, Los Alamos National Laboratory, DEBORAH SULSKY, University of New Mexico, and CARLA WOFSY, University of New Mexico.

Abstracts for consideration for these sessions should have been submitted by the **January 4, 1990** deadline. This deadline was previously published in the Invited Speakers and Special Sessions section of the *Notices* in our

Contributed Papers

There will also be sessions for contributed ten-minute papers. Late papers will not be accommodated.

Council

The Council of the AMS will meet at 7:00 p.m. Thursday, April 19, 1990, in the Fireplace Room at Sheraton Old Town Hotel.

Poster Session

A poster session of contributed papers will be organized.

Activities of Other Organizations

The Great Plains Operator Theory Seminar will also be held at the Sheraton Old Town Hotel, April 19–21, 1990.

Registration

The meeting registration desk will be located in the lobby of the Sheraton Old Town Hotel. The meeting registration desk will be open from 6:00 p.m. to 9:00 p.m. on Wednesday, April 18, and from 8:00 a.m. to noon on Thursday, April 19, Friday, April 20, and Saturday, April 21.

The registration fee is \$45, with a special \$25 fee for graduate students and unemployed mathematicians, and a one day fee of \$25.

Social Event

On Friday evening, April 20, there will be a reception and a no-host bar at the New Mexico Museum of Natural History. During the evening participants will have exclusive access to most of the exhibits at this outstanding museum. Further information will appear in the March issue of the *Notices*.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

David II Report

There will be a special presentation and discussion at the reception Friday evening concerning the upcoming National Research Council David II Report. This report is to be issued this spring and could have a major impact on all mathematics departments. The focus will be on becoming familiar with the report and discussing its use in our work.

Accommodations

A block of rooms is being held at the Sheraton Old Town Hotel, and at the Rio Grande Inn, which is within walking distance. Participants should make their own reservations directly with the hotels listed below and identify themselves as participants of the AMS and SIAM meeting in order to obtain the rates listed.

Participants must make reservations 45 days in advance of the meeting to be assured of the quoted rates. The American Mathematical Society is not responsible for rate changes or accommodations offered by hotels/motels in the following list.

Sheraton Old Town Hotel

800 Rio Grande Boulevard NW
Albuquerque, NM 87104

Telephone: 505-843-6300 or 800-237-2133

Single or Double \$53

Rio Grande Inn

1015 Rio Grande Boulevard NW
Albuquerque, NM 87104

Telephone: 505-843-9500

Single \$29

Double \$32

Travel

The Albuquerque Airport is served by most airlines. Both the Sheraton Old Town Hotel and the Rio Grande Inn provide free airport shuttle service. The Albuquerque City Bus (Sun-Tran) runs from the airport through the downtown area at seven minutes after the hour, and at thirty-seven minutes after the hour. The Sun-Tran Bus number is #50. Participants may board the bus on the west side of the airport on the lower level and the fare is sixty cents one-way. Cab service is also available for approximately seven dollars one-way.

Weather and Local Attractions

April temperatures in Albuquerque are mild, although participants are advised to bring a sweater or light jacket. Nearby ski areas may still be open at the time of the meeting. Old Town, in Albuquerque, has a historic plaza, Museum of Art, Museum of Natural History, and many restaurants, shops, and galleries. Albuquerque is also home to the world's longest tramway, the Sandia Peak Tramway.

Lance W. Small
Associate Secretary
La Jolla, California

MAA Contributed Paper Sessions at Columbus

The Joint Mathematics Meetings in Columbus, Ohio, will be held August 8 – 11 (Wednesday – Saturday), 1990. The first full announcement of the meeting will appear in the April 1990 issue of *Notices* and the March/April issue of *Focus*. This early preliminary announcement of the Columbus meeting is made to encourage MAA members' participation and to provide lead-time for organizing the MAA sessions on contributed papers. For more detailed information on the MAA's 75th anniversary celebration in Columbus, see Gerald Alexanderson's related article in January/February issue of *Focus*.

Contributed papers are being accepted on several topics in collegiate mathematics. The topics, organizers, their affiliations, and the days they will meet are:

- *Liberal arts mathematics courses*, SOLOMON A. GARFUNKEL, Consortium for Mathematics and its Applications (COMAP), Friday August 11 (and possibly Thursday, August 10).

This session will be devoted to the mathematical content and course design for liberal arts students. We are soliciting papers which address these themes in the context of long-term literacy goals as well as core undergraduate curriculum issues.

- *Toward equity and excellence: Efforts to increase the number of minorities and women in the profession*, CAROLYN R. MAHONEY, California State University at San Marcos, Friday, August 11 (and possibly Thursday, August 10).

Papers are welcome discussing precollege interventions, college and graduate school seminar workshops, and mentor programs, institutional initiatives as well as state and national efforts aimed at increasing participation of underrepresented groups.

- *The interface between mathematics and operations research*, LINN I. SENNOTT, Illinois State University Normal, Wednesday, August 9 (and possibly Thursday, August 10).

The session has two purposes: 1) to illustrate contributions of mathematics to the development of operations research via such topics as linear programming, queueing theory, etc., and 2) to acquaint mathematicians with the application of operations research models. Papers are solicited in either (or both) of these areas.

Presentations are normally limited to ten minutes, although selected contributors may be given up to twenty minutes. Individuals wishing to submit papers for any of these sessions should send the following information to the MAA Washington office at 1529 Eighteenth Street NW, Washington, DC 20036 by **May 18**:

1. Title
2. Intended session
3. A one-paragraph abstract (for distribution at the meeting)
4. A one-page outline of the presentation

Rooms where sessions of contributed papers will be held are equipped with overhead projector and screen. Blackboards are not normally available. Persons requiring other equipment needs should contact the MAA Associate Secretary (Kenneth A. Ross, Department of Mathematics, University of Oregon, Eugene, OR 97403) as soon as possible, but in any case prior to **June 1**. Upon request, the following will be made available: one additional overhead projector/screen, 35mm carousel projector, 16mm film projector, or VHS video cassette recorder with one color monitor.

Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

University Park, PA, April 1990

Robert T. Glassey	Lowell Edwin Jones
Karsten Grove	Gang Tian

Albuquerque, NM, April 1990

David Campbell	Robert May
Peter B. Gilkey	Alan Newell
Gundorph K. Kristiansen	Marc A. Rieffel

Columbus, OH, August 1990

Joseph G. Conlon	John Morgan
Michael G. Crandall	(Progress in Mathematics Lecture)
(Progress in Mathematics Lecture)	Michael E. Taylor
Saunders Mac Lane (AMS-MAA)	

Denton, TX, November 1990

Avner D. Ash	John Leucke
Peter S. Constantin	Clarence W. Wilkerson

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

April 1990 Meeting in University Park, Pennsylvania

Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: Expired

Ranee Kathryn Brylinski, *Classical and quantum groups*
Donald M. Davis, *Algebraic topology*

Thomas Farrell, *Geometric topology*
Gang Tian, *Recent progress on Einstein manifolds and related topics*

April 1990 Meeting in Albuquerque, New Mexico

Far Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: Expired

Richard C. Allen, José Castillo and Stanly Steinberg, *Numerical solution of partial differential equations*
Charles P. Boyer and Benjamin M. Mann, *Geometry and topology of moduli spaces*
Michael A. Buchner and Wojciech Kucharz, *Real algebraic geometry*
David Campbell and James M. Hyman, *Dynamical systems: low dimensional behavior in partial differential equations*
James Coronas, Paul Nelson and Daniel Seth, *Invariant embedding and inverse problems*
Howard Fegan and Alexander P. Stone, *Differential geometry*
James M. Hyman, W. T. Kyner, Ann Stanley, Deborah Sulsky and Carla Wofsy, *Mathematical biology*

August 1990 Meeting in Columbus, Ohio

Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: April 27, 1990

Eiichi Bannai, Thomas A. Dowling, Dijen Ray-Chaudhuri and Neil Robertson, *Combinatorics*
Susan Jane Colley and Gary Kennedy, *Algebraic geometry*
Zita M. Divis and David Terman, *Dynamics of biological systems*
S. K. Jain and S. Tariq Rizvi, *Ring theory*
Richard J. Nowakowski, *Combinatorial games*
Surinder K. Sehgal and Ronald Solomon, *Group theory*

October 1990 Meeting in Amherst, Massachusetts

Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: Expired
Deadline for consideration: July 16, 1990

November 1990 Meeting in Denton, Texas

Central Section

Associate Secretary: Andy Roy Magid

Deadline for organizers: February 15, 1990

Deadline for consideration: July 16, 1990

Ilya Bakelman, *Geometric inequalities and convex bodies*Scott T. Chapman and Nick H. Vaughan, *Commutative algebra*Lisa Mantini and Roger C. Zierau, *Representation theory of Lie groups*Mark S. Reeder, *Arithmetic groups*Peter F. Stiller, *Algebraic geometry***January 1991 Meeting in San Francisco, California**

Associate Secretary: Andy Roy Magid

Deadline for organizers: April 16, 1990

Deadline for consideration: September 19, 1990

March 1991 Meeting in South Bend, Indiana

Central Section

Associate Secretary: Andy Roy Magid

Deadline for organizers: June 16, 1990

Deadline for consideration: To be announced

March 1991 Meeting in Tampa, Florida

Southeastern Section

Associate Secretary: Joseph A. Cima

Deadline for organizers: June 22, 1990

Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the PCNM from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but can be found in "Rules for Special Sessions" on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the PCNM or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who

is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the PCNM well in advance of the meeting, and, in any case, at least nine (9) months prior to the meeting at which the Special Session is to be held, in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to the Associate Secretary, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in *Notices* in such a timely fashion that a member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. The deadline is usually three (3) weeks before the deadline for Abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. They are selected by the Section Program Committee. The processing of proposals for Special Sessions for Sectional Meetings is handled by the Associate Secretary for the Section who then forwards the proposals to the Section Program Committee, which makes the final selection of the proposals. Each Invited Speaker at a Sectional Meeting is invited to organize a Special Session. Just as for national meetings, no Special Session at a Sectional Meeting can be approved so late that its announcement appears after the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for publication of proceedings of any Special Session. If proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

Proposals for Special Sessions to the Associate Secretaries

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)

Lance W. Small, Associate Secretary

Department of Mathematics

University of California, San Diego

La Jolla, CA 92093

e-mail: g_small@math.ams.com

(Telephone 619-534-3590)

Central Section

Andy Roy Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
e-mail: g_magid@math.ams.com
(Telephone 405-325-2052)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
e-mail: g.comfort@math.ams.com
(Telephone 203-347-9411)

Southeastern Section

Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
e-mail: g.cima@math.ams.com
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Electronic submission of abstracts is now available to those who use the \TeX typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the Abstracts package, users should be sure to specify whether they want the plain \TeX , $\mathcal{A}\mathcal{M}\mathcal{S}\text{-}\text{\TeX}$, or the \LaTeX package.

Number of Papers Presented

Joint Authorship

Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting.

An individual may contribute only one abstract by title in any one issue of *Abstracts*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Joint Summer Research Conferences in the Mathematical Sciences

University of Massachusetts at Amherst, MA, June 7 to July 4, 1990

The 1990 Joint Summer Research Conferences in the Mathematical Sciences will be held at the University of Massachusetts at Amherst from June 7 to July 4. It is anticipated that the conferences will be supported by grants from the National Science Foundation and other agencies.

There will be six conferences in six different areas of mathematics. The topics and organizers for the conferences were selected by the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The selections were based on suggestions made by the members of the committee and individuals submitting proposals. The committee considered it important that the conferences represent diverse areas of mathematical activity, with emphasis on areas currently especially active and paid careful attention to subjects in which there is important interdisciplinary activity at present.

The conferences are similar in scientific structure to those held throughout the year at Oberwolfach. These conferences are intended to complement the Society's program of annual Summer Institutes and Summer Seminars, which have a larger attendance and are substantially broader in scope. The conferences are research conferences and are not intended to provide an entree to a field in which a participant has not already worked.

It is expected that funding will be available for a limited number of participants in each conference. Others, in addition to those funded, will be welcome, within the limitations of the facilities of the campus. In the spring a brochure will be mailed to all who are invited to attend the conferences. The brochure will include information on room and board rates, the residence and dining hall facilities, travel and local information and a housing form to use to request on-campus accommodations. Information on off-campus housing will also be included in the brochure. Participants should make their own housing and travel arrangements. Each participant will be required to pay nominal registration and social fees.

Those interested in attending one of the conferences should send the following information to the Summer Research Conference Coordinator, Meetings Department, American Mathematical Society, Post Office Box 6248, Providence, RI 02940, through electronic mail: CAK@MATH.AMS.COM on the Internet, or by

FAX: 401-331-3842.

Please type or print the following:

1. Title and dates of conference desired;
2. Full name;
3. Mailing address;
4. Telephone number and area code for office and home;
5. Member of AMS, IMS, or SIAM? If AMS, please give member code;
6. Your scientific background relevant to the topic of the conference;
7. Financial assistance requested; please estimate cost of travel;
8. Indicate if interested in attending if support is offered. Indicate if support is not required.

Funds may also be available for foreign graduate students under the Short Term Enrichment Program (STEP) of the United States Information Agency (USIA). Students must meet the following eligibility requirements:

1. must be enrolled in full-time graduate studies at a U.S. institution of higher education;
2. are not receiving any U.S. government funds for academic support;
3. are not on refugee, immigrant, or tourist visa status; and
4. have not been awarded STEP grants previously. Those eligible should include the following information when supplying the above eight items: 1. home country; 2. student status; 3. name of institution enrolled; 4. name of an official at the institution who can verify status; and 5. financial situation.

The deadline for receipt of applications is February 23, 1990. Requests for invitations will be forwarded to the Organizing Committee for each conference for consideration after February 23. Applicants selected will receive formal invitations and notification of financial assistance from the AMS. **Requests received past the deadline will be returned.** Funds available for the conferences are limited and individuals who can obtain support from other sources should do so. Women and members of minority groups are encouraged to attend and participate in these conferences.

Any questions concerning the scientific portion of the conference should be directed to the chair or a member of the Organizing Committee.

The Joint Summer Research Conferences in

Mathematical Sciences are under the direction of the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The following committee members chose the topics for the 1990 conferences: William B. Arveson, John A. Burns, Martin Golubitsky, Daniel J. Kleitman, Anthony W. Knap, Ingram Olkin, Mary Ellen Rudin, Stephen Simpson and Gregg J. Zuckerman.

Descriptions of the subject matter of each of the 1990 conferences appeared in the October and November *Notices*, pages 1087–1089 and 1242–1243 respectively; they were accompanied by lists of members of the respective Organizing Committees.

Thursday, June 7 to Wednesday, June 13

Probability models and statistical analysis for ranking data

MICHAEL A. FLIGNER (The Ohio State University), Co-Chair,
JOSEPH S. VERDUCCI (The Ohio State University), Co-Chair

Thursday, June 7 to Wednesday, June 13

Inverse scattering on the line

DAVID SATTINGER (University of Minnesota, Minneapolis), Chair

Thursday, June 14 to Wednesday, June 20

Deformation theory of algebras and quantization with applications to physics

MURRAY H. GERSTENHABER (University of Pennsylvania), Co-Chair

JAMES D. STASHEFF (University of North Carolina at Chapel Hill), Co-Chair

Thursday, June 21 to Wednesday, June 27

Strategies for sequential search and selection in real time

THOMAS S. FERGUSON (University of California, Los Angeles), Co-Chair

STEPHEN M. SAMUELS (Purdue University), Co-Chair

Thursday, June 21 to Wednesday, June 27

Schottky Problems

LEON EHRENPREIS (Temple University), Co-Chair

ROBERT C. GUNNING (Princeton University), Co-Chair

Thursday, June 28 to Wednesday, July 4

Logic, local fields, and subanalytic sets

LOU VAN DEN DRIES (University of Illinois at Urbana-Champaign), Chair



UNFOLDINGS AND BIFURCATIONS OF QUASI-PERIODIC TORI

H. W. Broer, B. Huitema, F. Takens, and B. L. J. Braaksma
(Memoirs of the AMS, Number 421)

In the theory of dynamical systems, the occurrence of equilibria and periodic motions, as well as their general persistence and stability properties, are now fairly well understood. Researchers also have some systematic insight into the role of external parameters. This book aims to mimic this classical theory in the case of quasi-periodic motions. These motions are most familiar in the context of the conservative dynamics of classical mechanics, but they also occur with dissipative dynamics—for example, quasi-periodic attractors play a role in the onset of turbulence.

In the first part of the book, the authors present a general treatment of the use of external parameters in various contexts, employing notions such as integrability and transversality. The second part, dealing only with dissipative cases, studies bifurcations when the hyperbolicity is mildly violated. Readers will appreciate the way the book systematically ties together a number of cases for quasi-periodicity and the resulting improvement of accuracy. In addition, a number of new applications are presented.

1980 *Mathematics Subject Classifications*: 58, 34
ISBN 0-8218-2483-X, LC 89-18093
ISSN 0065-9266

188 pages (softcover), January 1990
Individual member \$13, List price \$22,
Institutional member \$18
To order, please specify MEMO/421NA

All prices subject to change. Shipment will be made by surface. For air delivery add, 1st book \$5, each additional book \$3, maximum \$100. *Prepayment required.* Order from American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS (321-4267) in the U. S. and Canada to charge with VISA or MasterCard.

1990 Summer Seminar in Applied Mathematics

Vortex dynamics and vortex methods

University of Washington, Seattle, June 18–29

The twenty-first AMS-SIAM Summer Seminar in Applied Mathematics will be held June 18–29, 1990, at the University of Washington, Seattle. The seminar will be sponsored jointly by the American Mathematical Society and the Society for Industrial and Applied Mathematics. It is anticipated that the seminar will be supported by a grant from federal agencies. The proceedings of the seminar will be published by the AMS in the *Lectures in Applied Mathematics* series.

The subject of this seminar will be the study of vorticity-dominated fluid motion. Numerical techniques and their applications will be discussed (in particular, there will be several talks about discrete vortex methods). Applied mathematical analysis and laboratory experiments will be additional lecture subjects. A combination of introductory exposition and recent research results will be presented in the lectures. A goal of the seminar is to bring together researchers with different viewpoints in order to suggest new approaches and to facilitate critical evaluations of existing techniques for the study of vorticity-dominated flows.

A partial list of invited speakers includes J. BELL, Lawrence Livermore National Laboratories; T. BUTTKE, Courant Institute of Mathematical Sciences, NYU; R. CAFLISCH, University of California, Los Angeles; A. J. CHORIN, University of California, Berkeley; W. DAHM, University of Michigan; J. FERZIGER, Stanford University; A. GHONIEM, Massachusetts Institute of Technology; R. GLOWINSKY, University of Houston; W. HENSHAW, IBM T.J. Watson Research Center; T. HOU, Courant Institute of Mathematical Sciences, NYU; A.K.M.F. HUSSAIN, University of Houston; R. KRASNY, University of Michigan; H.-O. KREISS, University of California, Los Angeles; A. MAJDA, Princeton University; P. MARCUS, University of California, Berkeley; E. MEIBURG, Brown University; J. NEU, University of California, Berkeley; S. ORSZAG, Princeton University; J. SETHIAN, University of California, Berkeley; M. SHELLEY, University of Chicago; and G. TRYGGVASON, University of Michigan.

The Organizing Committee consists of CHRISTOPHER R. ANDERSON, University of California, Los Angeles, co-chair; STEPHEN CHILDRESS, Courant Institute of Mathematical Sciences, NYU; GEORGES-HENRI COTTET, University of California, Los Angeles and Ecole Polytechnique, Paris; CLAUDE GREENGARD, IBM T.J. Watson

Research Center, co-chair; and ANTHONY LEONARD, California Institute of Technology.

A brochure will be available from the AMS which will include information on accommodations and local information. Participants will be required to pay a \$20 registration fee and a \$25 social fee.

Those interested in attending the seminar should send the following information to the Summer Seminar Conference Coordinator, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, by electronic mail: BAV@MATH.AMS.COM, or by FAX: 401-842-3842 before March 23, 1990.

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home. E-mail address (if applicable);
4. Member of AMS or SIAM? Include customer number if an AMS member;
5. Anticipated arrival and departure dates;
6. Your scientific background relevant to the topic;
7. Financial assistance requested (estimate cost of travel);
8. Indicate if interested in attending if support is offered. Indicate if support is not required.

Participants who wish to apply for a grant should so indicate; however, funds available for the seminar are very limited and individuals who can obtain support from other sources should do so. Graduate students who have completed at least one year of graduate school are encouraged to participate.

Funds may also be available for foreign graduate students under the Short Term Enrichment Program (STEP) of the United States Information Agency (USIA). Applicants must meet the following eligibility requirements: 1. must be enrolled in full-time graduate studies at a U.S. institution of higher education; 2. are not receiving any U.S. government funds for academic support; 3. have not been awarded STEP grants previously; 4. are not on refugee, immigrant, or tourist visa status; 5. are eligible should include the following information: 1. home country; 2. student status; 3. name of institution enrolled; 4. name of an official at the institution who can verify status; 5. financial situation.

1990 Summer Research Institute

Differential Geometry

University of California, Los Angeles, July 8-28

The thirty-eighth Summer Research Institute sponsored by the American Mathematical Society will be devoted to *Differential Geometry* and will take place at the University of California, Los Angeles. Members of the Organizing Committee are: ROBERT BRYANT, Duke University; EUGENIO CALABI, University of Pennsylvania; S. Y. CHENG, University of California, Los Angeles; H. BLAINE LAWSON, State University of New York, Stony Brook; H. WU, University of California, Berkeley; ROBERT E. GREENE, University of California, Los Angeles (co-chair); and S. T. YAU, Harvard University (co-chair).

It is anticipated that the institute will be partially supported by a grant from the National Science Foundation. Proceedings of the institute will be published in the AMS series *Proceedings of Symposia in Pure Mathematics*.

This topic was selected by the 1988 AMS Committee on Summer Institutes and Special Symposia whose members at the time were: STEVEN L. KLEIMAN (chair), HAYNES R. MILLER, RAGHAVAN NARASIMHAN, PAUL H. RABINOWITZ, THOMAS C. SPENCER, and ROBERT B. WARFIELD, JR..

The years since the last AMS Summer Institute on differential geometry, held in 1973, have been a period of explosive growth and exciting research in this subject. Seen in retrospect, the 1973 institute both recounted the accomplishments in geometry in the 1960's and early 1970's and at the same time marked some new directions for the field. Riemannian geometry in the purest sense along with the theory of characteristic classes in geometry were enjoying a triumphant period. The previous decade had seen the quarter-pinching Sphere Theorem results, on complete open manifolds of nonnegative curvature, the use of heat kernel asymptotics in invariant theory, the discovery of new invariants, and the rapid growth of the theory of foliations. The 1973 institute also heralded a new era just beginning: work on prescribed curvature, the renewed interest in the spectrum of the Laplacian, and the beginning of the study of complex manifolds using analytic $\bar{\partial}$ methods. These were all portents of a new growth period which would involve a vast increase in the use of partial differential equations in geometry.

Partial differential equations arise naturally in geometry. The association of curvature tensor to metric is itself a partial differential operator, which could be thought of as the central object of the whole subject.

Many other operators also arise naturally, as the Euler-Lagrange equations for variational problems. Naturally arising variational problems yield the minimal submanifold equations, the equations for harmonic maps, the complex Monge-Ampere equation for the Ricci curvature of a Kähler manifold, and the Yang-Mills equations. Since the early 1970's, significant progress has been made in understanding all these partial differential equations and many others on manifolds. In a virtually unprecedented way, it has become possible to approach the problems of geometry by direct study of the relevant partial differential equations. The results have transformed the subject of differential geometry.

Any reasonably short list of specific theorems will be necessarily partial, so numerous are the results, but some highlights will help to indicate the magnitude of the progress made: the solution of the Calabi Conjecture on the existence of canonical Einstein-Kähler metrics; the related constructions of a canonical complete Einstein-Kähler metric on pseudoconvex domains in C^n ; the solution of the positive mass conjecture of relativity; the classification of manifolds of positive scalar curvature; results on minimal surfaces in 3-manifolds which were instrumental in the proof of the Smith Conjecture; the use of harmonic maps to prove rigidity theorems for complex manifolds; the characterization of C^n by curvature and related results on gap phenomena for Riemannian manifolds; the development of harmonic function theory on manifolds; the construction of surfaces of constant mean curvature; new results on differential systems; the determination of the possible holonomy groups; the solution of the Frankel conjecture on compact Kähler manifolds of nonnegative bisectional curvature; the solution of the Yamabe problem; the deformation of manifolds of positive Ricci curvature to constant positive; and the existence of canonical metrics on stable vector bundles.

Special mention should be made of the spectacular geometric results arising from Yang-Mills theory. Yang-Mills theory is again an example of an extremal problem, in this case in effect the minimization of the square integral of the curvature of a connection on a principal bundle. When the bundle lies over a 4-dimensional manifold, an additional structural feature arises in that the Hodge star takes the curvature 2-form again to a 2-form, so that 2-forms can be symmetrized and an-

tisymmetrized relative to this operation. Out of this rich geometric structure arises the possibility of proving profound differential topological results on 4-manifolds by geometric methods. The most spectacular of these is perhaps the existence of "exotic" (nonstandard) differentiable structures on topological R^4 .

There have also been revolutionary developments in Riemannian geometry outside the partial differential equations methods. New concepts and methods involving the limiting behavior of metrics and the structure of the space of Riemannian manifolds as a whole have given new life to manifold geometry. Highlights include: the characterization of almost flat manifolds; the bounds on the Betti numbers of manifolds of nonnegative curvature; finiteness and convergence theorems for manifolds satisfying curvature bounds; and a comprehensive theory of manifolds of negative curvature.

The general intention for the 1990 Summer Institute is to cover not only developments in differential geometry itself, but also related topics in other parts of mathematics and in physics. The planned format is to have a number of one hour survey lectures in the morning sessions offering more broadly sketched viewpoints, followed in the afternoons by shorter, more specialized seminar lectures in parallel sessions. For organizational purposes the subject will be divided into eight subdivisions: 1. Riemannian geometry; 2. Minimal submanifolds; 3. Complex geometry and L^2 cohomology; 4. General theory of partial differential equations on manifolds: harmonic functions and mappings, Monge-Ampere equation, differential systems, and isometric embedding; 5. Eigenvalues, heat flow, and index theory; 6. Gauge theory and geometry in mathematical physics; 7. Groups and manifolds, and dynamical systems; 8. Symplectic geometry.

While it is anticipated that seminar activity on all these topics will continue throughout the three weeks of the institute, each week will have a different specific emphasis on two or more of the eight topics. A tentative list of the topics to be addressed follows. Please note, however, that the program is subject to change:

Week One: July 8 - 14: Minimal submanifolds; general theory of partial differential equations on manifolds (harmonic functions and mappings, Monge-Ampere equation, differential systems, isometric embedding); eigenvalues, heat flow and index theory.

Week Two: July 15 - 21: Gauge theory and geometry in mathematical physics; symplectic geometry; complex geometry and L^2 cohomology.

Week Three: July 22 - 28: Riemannian geometry; groups and manifolds, and dynamical systems.

The names of the survey lecturers will be provided in a future announcement.

Accommodations will be available in the campus residence halls for participants; cafeteria style meals will be available. All facilities will be accessible to the handicapped.

Information on housing, dining, travel and the local area will be sent to invited participants in the spring. Each participant will pay a registration fee and a travel fee to cover the costs of social events scheduled during the institute.

Those interested in receiving an invitation to participate in the institute should send the following information to the Summer Institute Conference Coordinator, American Mathematical Society, Post Office Box 618, Providence, RI 02940, **prior to April 1, 1990** or through electronic mail: WSD@MATH.AMS.COM, or by telephone: 401-331-3842.

Please type or print the following:

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Which week or weeks you wish to attend;
5. Your scientific background relevant to the institute topic;
6. Financial assistance requested;
7. Indicate if interested in attending if support is offered. Indicate if support is not required.
8. If member of AMS, give AMS member code.

Funds may also be available for foreign graduate students under the Short Term Enrichment Program (STEP) of the United States Information Agency (USIA). Students must meet the following eligibility requirements: 1. must be enrolled in full-time graduate studies in a U.S. institution of higher education; 2. are not receiving any U.S. government funds for academic support; 3. are not on refugee, immigrant, or tourist visa status; 4. have not been awarded STEP grants previously. Those eligible should include the following information in supplying the above eight items: 1. home country; 2. student status; 3. name of institution enrolled; 4. name of an official at the institution who can verify status and financial situation.

Requests for invitations will be forwarded to the Organizing Committee for consideration up to the deadline of **April 1**, and applicants selected will receive their invitations and notification of financial assistance by mid-May.

Mathematics Sessions at the AAAS Annual Meeting

New Orleans, Louisiana, February 15-20, 1990

The 1990 Annual Meeting of the AAAS, February 15-20 in New Orleans, will feature many outstanding expository talks by prominent mathematicians. These include the following symposia (three-hour sessions) and invited talks cosponsored by Section A (Mathematics) of the AAAS and the Society. The names and affiliations of the organizers follow (speakers' names are given in parentheses):

- *Radon and Penrose transforms: Medical imaging to supersymmetry*, organized by JAMES V. PETERS, Long Island University, C.W. Post Center, and TODD QUINTO, Tufts University. (Allan Cormack, Gabor Herman, Larry Shepp, Ron O. Wells)
- *New directions in the philosophy of mathematics*, organized by REUBEN HERSH, University of New Mexico. (Gian-Carlo Rota, Thomas Tymoczko, Nicholas Goodman, Hao Wang, Martin Krieger, Michael Resnik)
- *Computational and mathematical modeling: A study of oil production and water resources*, organized by JAMES G. GLIMM, New York University. (James Glimm, Richard Ewing, Brent Lindquist, Larry Lake, David Wilkinson)
- *Geometry today*, organized by ERWIN LUTWAK, Polytechnic University of New York, and RALPH ALEXANDER, University of Illinois at Urbana. (George Francis, Vladimir Olikier, Herman Gluck, Gian-Carlo Rota)
- *Zero knowledge proofs and their applications*, organized by SILVIO MICALI, Massachusetts Institute of Technology. (Shafi Goldwasser, Manuel Blum, Silvio Micali)

- *Frontiers of physical sciences: A mathematics lecture* by FRANK MORGAN, Williams College.
- *One day short course on Chaotic dynamical systems* by ROBERT L. DEVANEY, Boston University.

Section A of the AAAS is also cosponsoring various symposia that will be of interest to mathematicians and mathematics educators. These include:

- *Chaos in the balance of nature*
- *Symmetry: Its theory and application through science*
- *Mathematical models in the social sciences*
- *The contributions of R.A. Fisher to science* (symposium commemorating the centennial of R.A. Fisher's birthday)
- *Revitalizing science and mathematics education through the use of technology*
- *Project approaches in developing new introductory physics, chemistry, and mathematics curricula*
- *The development of pre-adult attitudes toward science and mathematics in Japan and the United States.*

A meeting of the Section A Committee will take place from 4:00 p.m. to 6:00 p.m. on February 15 in Marlborough B Room of the New Orleans Hilton. The committee meeting is open to all who wish to stimulate interest and activities of the mathematical sciences within the AAAS.

For details see the November 10, 1989, issue of *Science*. Additional information on Section A activities can be found in the *News and Announcements* section of the November 1989 issue of *Notices*.



International Congress of Mathematicians

Kyoto, JAPAN

August 21-29, 1990

Second Announcement

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- Form B Abstract Form p. 209:
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To Secretariat ICM-90

Important Deadlines

- Preregistration at reduced rate, **May 15, 1990**
- Preregistration in U.S. dollars, **May 15, 1990**
- Short Communications, **April 15, 1990**
- These should be accompanied by preregistration document and fee
- Accommodation and Excursions, **June 30, 1990**
- Cancellation of Preregistration with refund, **June 30, 1990**

The logo, designed by K. Aoki and Y. Komai, has three meanings: a Japanese stone lantern, the first character of Kyoto, and the character for 10¹⁶.

ICM-90 Address, Telephone, Fax, Telex and Email

Secretariat ICM-90
Research Institute for Mathematical Sciences
Kyoto University
Kitashirakawa, Sakyo-ku
Kyoto 606, JAPAN
Telephone: (075)722-1278
Fax: (075)753-7272
Telex: 5422020 RIMS J
Email*: icm90@kurims.kyoto-u.ac.jp
*Alternative Email address:
icm90%kurims.kyoto-u.ac.jp@relay.cs.net

In Telephone and Fax numbers, 075 is for the Kyoto area, not needed when calling from inside Kyoto, and is to be omitted when calling from outside of Japan.

Preamble

The Organizing Committee is pleased to invite you to attend the International Congress of Mathematicians, Kyoto, JAPAN, August 21-29, 1990.

This announcement describes the Congress, related information and explains how to register. detachable page 35 is the registration form.

ICM-90 will be held under the auspices of the International Mathematical Union and under the sponsorship of the Science Council of Japan, the Mathematical Society of Japan, the Japan Society of Mathematical Education, The History of Science Society of Japan, The Institute of Actuaries of Japan, the Japan Society for Science and Technology, The Japan Statistical Society and The Operations Research Society of Japan.

1. Location of the Congress

The Congress will be held at the Kyoto International Conference Hall (KICH) located in the northern part of Kyoto City.

Kyoto International Conference Hall
(Abbreviated as KICH in the following.)
Address: Takaraga-ike, Sakyo-ku, Kyoto 606, JAPAN
Telephone: (075)791-3111

Telex: 5422353 INTHAL J

Fax: (075) 711-1100

Cable: INTHALL KYOTO

For details, see 5. Travel (pages 191-193). The maps showing important locations are on pages 201-202.

2. Outline of the Program

The tentative program of the Congress is summarized in the following table. Some changes in the program may become necessary depending on the number of speakers.

A more definitive and detailed program will appear in the Third Announcement, which will be mailed to those who preregister for ICM-90.

The KICH building will open at 9 and will close 30 minutes after the close of the official program. It will not be available on **Sunday, August 26**.

	Morning		Afternoon	Evening	
Tue., Aug. 21	Opening Ceremony	L U N C H	Works of Prize Winners	Reception Party	
Wed., Aug. 22	(A)		(B)	Parallel Sessions	Concert
Thu., Aug. 23	Plenary Addresses				
Fri., Aug. 24					
Sat., Aug. 25			Musical Performances		
Sun., Aug. 26	Optional Excursions				
Mon., Aug. 27	(A)	Lunch	(B)		
Tue., Aug. 28	Plenary Addresses				Parallel Sessions
Wed., Aug. 29	(C) Plenary Addresses	Closing Ceremony	Banquet		

(A) One hour Plenary Addresses: 9:30-10:30 & 11:00-12:00.

(B) 45-minute invited Section Lectures in 6 Parallel Sessions: 13:30-, 14:30-, 16:00-, 17:00-, 18:00-; 10-minute short communications in 8 Parallel Sessions; Coffee break 15:15-16:00.

(C) One hour Plenary Addresses: 9:30-10:30, 10:45-11:45, 12:00-13:00.

3. Mathematical Activities

(a) Works of Prize Winners

The Fields Medals and the Rolf Nevanlinna Prize will be presented at the Opening Ceremony, and presentation of works of the winners will be given in the afternoon between 14:00-16:00.

(b) Plenary Addresses

At the recommendation of the Program Committee, appointed by the International Mathematical Union (IMU), the Organizing Committee has invited 15 mathematicians to give one-hour Plenary Addresses. These addresses are intended to inform participants of major concepts, problems and trends in mathematics, and should be comprehensible to a wide audience.

We plan to show videotapes of the Plenary Addresses in the afternoon (except Saturday, Sunday and the last day) for the benefit of participants who either missed a talk or who would like to see it again.

(c) Invited Section Lectures

Also at the recommendation of the IMU Program Committee, about 140 mathematicians have been invited to give 45-minute lectures in specified sections. These lectures are intended to be surveys of significant topics related to the area of the sponsoring section, and are also accessible to nonspecialists who have closely related interests.

The list of sections is as follows. The number in parentheses indicates the approximate number of invited 45-minute lectures in that section.

1. Mathematical logic and foundations (4)
2. Algebra (8)
3. Number theory (8)
4. Geometry (10)
5. Topology (9)
6. Algebraic geometry (7)
7. Lie groups and representations (7)
8. Real and complex analysis (10)
9. Operator algebras and function analysis (7)
10. Probability theory and mathematical statistics (9)
11. Partial differential equations (10)
12. Ordinary differential equations and dynamical systems (8)
13. Mathematical physics (11)
14. Combinatorics (7)
15. Mathematical aspects of computer science (6)
16. Computational methods (7)
17. Applications of mathematics to the sciences (5)
18. History, teaching and the nature of mathematics (4)

(d) ICMI Lectures

The International Commission on Mathematical Instruction is planning five 45-minute invited talks during ICM-90. They will be scheduled using some spots in the last part of the Parallel Sessions for invited speakers each day.

(e) Short Communications

Ordinary members of ICM-90 will have the privilege of presenting a 10-minute oral communication of their

mathematical work (as long as capacity permits), provided that they have preregistered by **April 15, 1990**, and have also submitted an abstract, including the title of their talk and the number of the appropriate section (as listed above) by that date. After screening by the Science Committee, the acceptance/rejection of the paper (along with the section in which the paper is accepted) will be notified by the Acceptance/Rejection Card on page 205.

Abstracts may be submitted in English, French, German, and Russian. Abstracts of accepted short communications which are properly prepared and received by the deadline, will be reproduced and distributed to all Ordinary Members when they pick up their Registration Packet in Kyoto. Late papers will not be accepted. Only one short communication is allowed for each Ordinary Member.

Instructions on how to prepare an abstract are on page 207. An Abstract Form is on page 209.

Important Points

*Preregistration of the speaker is a requirement for the acceptance of the short communication.

*Be sure that your name appears on the abstract in exactly the same form as it appears on the Preregistration Form.

*Abstracts of short communications should be submitted in the same envelope as the Preregistration Form of the speaker.

*The deadline is **April 15, 1990**. The abstract together with the preregistration document must reach us by that date.

*Reply Postcards

Please enclose the two postcards on page 206. Do not forget to write the title of the paper on one side of the Acceptance-Rejection Card and the author's address on the other side of both cards. The Acknowledgment card will be returned upon receipt of the preregistration and abstract (after confirmation of payment of the registration fee); the Acceptance-Rejection card will be returned later regarding the acceptance of the abstract.

(f) Informal Seminars

Ordinary Members who wish to organize spontaneous seminars are asked to make all arrangements among themselves, either in advance or during ICM-90, and to request a room for a specified time from the ICM-90 Secretariat. Such seminars cannot be scheduled at the same time as the Plenary Addresses, but may take place during the afternoons as long as rooms are available. If the ICM-90 Secretariat is notified of a seminar by 15:00 the day before, an announcement of the seminar will be included in the Daily Newsletter which will be distributed to all participants the following day.

(g) Chalk-Talk Rooms

Several small rooms equipped with blackboards will be set aside for informal mathematical discussions among participants. Participants are asked to limit their use of these rooms to one hour as a courtesy to other participants. The room numbers and locations will be made available at the Registration Desk of the Congress. The rooms will be closed after the scheduled closing hours of official programs. They are also closed during the Reception and the Banquet.

(h) Other Mathematics Conferences

Several independent international mathematics conferences are being planned in Japan just prior to or after the Congress. The latest list of such conferences is enclosed for those who are interested. Conferences of the same kind taking place near Japan are also included in the list to the extent known to us. Inquiries about all these conferences should be directed to the respective organizers. (See Mathematical Sciences Meetings & Conferences this issue p. 223 under August & September 1990.)

4. Social Programs

(a) Opening and Closing Ceremonies

The Opening Ceremony will be held at the Kyoto International Conference Hall (KICH) at 9:30 on **Tuesday, August 21**, accompanied by traditional court music and dance (Gagaku and Bugaku). Participants should arrive at the main entrance of KICH well in advance so as to have ample time to complete registration.

As part of the Opening Ceremony program, the Fields Medals and the Nevanlinna Prize will be awarded.

Presentation of the works of the medalists and the prize winner will be given in the afternoon at the Main Hall from 14:00.

The Closing Ceremony will be held at the Main Hall on **Wednesday, August 29** at 13:15.

(b) Reception

All members of the Congress are invited to the reception party to be given at the Event Hall of KICH on **Tuesday, August 21** at 17:00. This program is complimentary.

(c) Traditional Musical Performances

All members of the Congress are invited to attend Japanese traditional musical performances to be given at the Event Hall of KICH on **Saturday, August 25** 15:00-17:20. This event will include traditional Japanese instrument and dance presentations such as flute, shamisen (a string instrument), the lion dance, Kyogen (dance), and Iwami Kagura (Shinto sacred music dancing). This program is complimentary.

5. Travel

(d) Concert

A Cello recital by Takuro Mori is scheduled in the evening on **Thursday, August 23**. Admission is free for registered members. Interested persons are requested to pick up tickets/programs at the registration desk.

(e) Banquet

All Members of the Congress are invited to the Farewell Banquet to be held in the Event Hall of KICH on **Wednesday, August 29**, from 14:00 to 16:00. This program is complimentary.

(f) Excursions

Sunday, August 26 will be set aside for optional excursions and no lectures will be scheduled on this day. The Japan Travel Bureau offers bus tours Ex1-Ex4 in List B on page 197.

Bookings for these tours can be made by sending in the enclosed Form C on page 211. Payment of the fee is to be made to the Japan Travel Bureau. The method of payment is described in the Form C. The Organizing Committee will subsidize ¥3,000 for each Ordinary/Accompanying Member. Please note that the subsidy is not available for on-site application. Those Ordinary and Accompanying Members who are not participating in tours Ex1-Ex4 can receive a one-day pass for buses & subways of Kyoto city by application in Form C. This pass can be used an unlimited number of times on August 26.

(g) Program for Accompanying Members

The programs in List A on page 196 will be held in rooms of KICH. These programs are complimentary.

A visit to the Handicraft Center for traditional handicraft demonstrations and shopping will be organized, separate from PA2 and PA14 in List C. Other visits to places for traditional handicrafts of Kyoto are being planned. Their Schedule will be announced in KICH at the time of the conference.

Bus tours PA1-PA16 in List C on pages 198-199 are offered by the Japan Travel Bureau and can be booked by sending in the enclosed Form C. Payment of the fee is to be made to the Japan Travel Bureau. The method of payment is described in the Form C. Support is available from the Congress at the rate of ¥2,000 per person. You can deduct ¥2,000 times the number of Accompanying Members who are participating at the PA-programs in List C. This amount is (F) in the Application Form on page 212. Please note that this subsidy is not available for on-site application.

Ordinary Members can participate in these programs for Accompanying Members but the subsidy is not available.

(a) Access to Kyoto

The Kyoto International Conference Hall is located in the northern part of Kyoto City. The airport closest to Kyoto is Osaka International Airport, which is about 55 minutes to Kyoto by the airport bus service. The buses leave the airport every 20 minutes between the hours of 7:55 to 21:30. The bus fare to Kyoto Station (the first stop) is ¥800. Buses leaving the airport 40 minutes after the hour stop at several hotels beyond Kyoto Station while the other buses stop only at Kyoto Station. For two or more stops beyond Kyoto station, the bus fare is ¥860.

Kyoto is located 500 km west of Tokyo. A bullet train service (Shinkansen) from Tokyo to Kyoto is available every 10-30 minutes from 6:00 to 21:00. It takes about 2 hours and 45 minutes, and the current fare is ¥13,170 one way, economy class, ¥17,720 one way for green cars (1st class) which have wider seats and more leg room. (These prices are for high seasons such as August.)

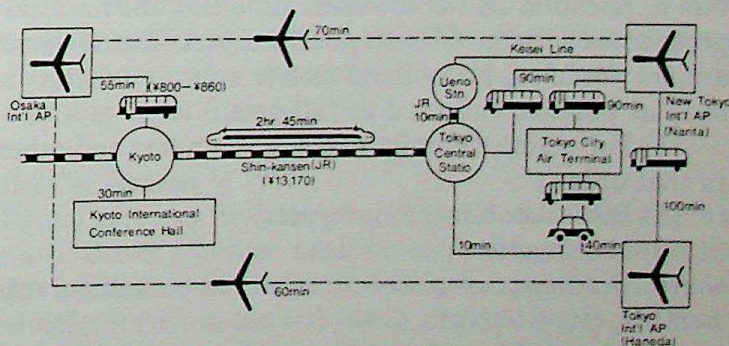
It would be advisable to book an international flight to Osaka (possibly via Narita Airport). For those who arrive at the New Tokyo International Airport (Narita) one of the following four routes to Kyoto are possible:

1. Take a domestic flight from Narita to Osaka (but there are only few flights available).

2. Take a domestic flight to Osaka from Haneda Domestic Airport in Tokyo. However, this requires an airport-limousine bus transfer from Narita to Haneda, which takes about 2 hours. About 15 flights are available from Haneda to Osaka each day. It is advisable to make a reservation before leaving your country.

3. Take an airport-limousine bus to Tokyo Station and then board a Shinkansen train to Kyoto (see above). It will probably take 3 hours from the arrival of the flight to boarding the train.

4. Take the Keisei Line (train) to Ueno station, the JR line to Tokyo station and then Shinkansen as explained above.



(b) ICM-90 Information on Arrival

In the afternoon and evening of **August 20**, ICM-90 personnel carrying ICM-90 sign will be available as guides at following 3 places: (i) at the arrival hall of Osaka International Airport, (ii) Kyoto Station, and (iii)

at the first airport bus stop in Kyoto. Participants are advised to complete registration at the Keihan Hotel, just in front of the bus stop and towards left across the street from Shinkansen Kyoto Station (Hachijoguchi Exit on the south side). Free Congress buses will be available from there to hotels. The Congress Admission Badge obtained at the registration will entitle you to use them.

(c) About Kyoto

Kyoto, surrounded by gracefully wooded hills, was the capital of Japan from 794 A.D. to 1868 A. D. Besides two beautiful Imperial Villas, Kyoto has about 400 Shinto shrines and 1,650 Buddhist temples which dot the entire city. Kyoto offers innumerable cultural treasures and traditional crafts and attracts visitors from throughout the world as well as from within Japan. The city of Nara, which is an ancient capital and another renowned sightseeing center of old Japanese culture, can be reached within 30 minutes from Kyoto by an express train and makes an excellent one-day excursion.

(d) Passports and Visas

Every foreign national coming to Japan must have a valid passport.

Citizens of the countries which have Reciprocal Visa Exemption Arrangements with Japan (listed at the bottom of the page) are not required to have a visa to enter Japan for a short stay.

Citizens of all other countries must obtain a visa from a Japanese Embassy or Consulate prior to entering Japan. A visa cannot be issued in Japan.

Visa Application

To apply for a visa, one is usually requested to submit a letter of invitation. Therefore please send us the following information as soon as possible which will enable us to send you an invitation letter specifically for visa application and at the same time take the necessary procedures with our Ministry of Foreign Affairs. If details are not yet fixed, please send us a temporary itinerary as soon as possible and send us full details later.

- (1) Full name. (Family name, given name and others in that order.)
- (2) Birth date (day/month/year).
- (3) Nationality.
- (4) Address, telephone number, fax number, telex number, etc.
- (5) Name of your Institution and your position there.
- (6) Full itinerary in Japan with dates and purposes (the date of entry to Japan, conferences [ICM-90, satellite conferences] with dates of your attendance, Universities with dates of visit, itinerary of sightseeing and the date of departure from Japan).

It is advisable that foreign participants apply for a visa at least 3 months before the date on which they plan to

enter Japan. Furthermore, when applying, the participant should inform the Japanese Consular Office that he/she will be attending an international congress held under the auspices of an ICSU member Union. If an applicant has not received a visa at least one month before the beginning of ICM-90, he/she is requested to contact us by fax, telex or other rapid means of communication to give us the following information:

- Name and address of applicant,
- Passport number,
- Date and place of visa application.

Appropriate efforts will be made immediately to resolve any problems, and information about the status of the visa application will be communicated to the participant. Should a participant apply for a visa through a Japanese Consular Office located outside of his/her own country, this information should be conveyed to us.

Countries having Reciprocal Visa Exemption Arrangements with Japan

As of July, 1989, citizens of the following countries are not required to obtain visas for a stay of 3 months or less (6 months or less for those with *): [Since there are occasional changes in the list, please check the current situation at any Japanese Consulate in your country.]

Austria*, Federal Republic of Germany*, Ireland, Liechtenstein*, Mexico*, Switzerland*, United Kingdom, Argentina, Bahama, Barbados, Belgium, Canada, Chile, Columbia, Costa Rica, Cyprus, Denmark, Dominican Republic, El Salvador, Finland, France, Greece, Guatemala, Honduras, Iceland, Iran, Israel, Italy, Lesotho, Luxembourg, Malta, Malaysia, Mauritius, Netherlands, New Zealand, Norway, Peru, Portugal, San Marino, Singapore, Spain, Suriname, Sweden, Tunisia, Turkey, Uruguay, U.S.A., Yugoslavia.

14 days or less for Brunei.

(e) Official Airline

Japan Air Lines (JAL) is the official carrier for the Congress. Please contact the nearest JAL overseas office for the appropriate air schedules.

(f) Official Travel Agency

The Japan Travel Bureau, Inc. (JTB) Kyoto Office has been appointed as an official travel agency for the Congress and is prepared to handle all travel arrangements related to the Congress. Hotel information is on page 193 and the Hotel Booking Form is on page 21.

Japan Travel Bureau, Inc.
Kyoto Office
Convention dept.
Higashi-shioxoji-cho, Shimogyo-ku
Kyoto 600, JAPAN
Tel: (075) 361-7241
Fax: (075) 341-1028
Telex: 5422014 JTBKYT J

JTB will maintain a desk in the Kyoto International Conference Hall for the duration of the Congress. Reconfirmation of flight reservations and other travel arrangements can be made there.

(g) Group Flights

Participants who are interested in joining group flights from Europe and the U.S.A. are advised to contact the following travel agents. They will be pleased to provide information on reasonably priced group flights.

[Europe]

STATUS

Festival Hall, Petersfield
Hampshire, GU31 4JW

ENGLAND

TEL: (0730)88544

FAX: *0730)68865

[U.S.A.] (West)

Japan Travel Bureau
International INC.

Suite 220,

5000, Birch St.

Newport Beach, CA 92660

TEL: (714) 476-8586

FAX: (714) 476-8695

[U.S.A.] (East)

Japan Travel Bureau
International INC.

Equitable Tower 11th Floor
787 Seventh Ave.

New York, N.Y. 10019

TEL: (212) 246-8030

FAX: (212) 246-5607

(h) Currency Exchange

Major banks that handle foreign currencies are located in the downtown area of Kyoto. Banks are open from 9:00 to 15:00 on weekdays. They are closed on Saturday, Sunday, and National Holidays (that is, closed on August 25 and 26). Major foreign currencies can also be exchanged at larger hotels. It is recommended that participants purchase traveler's checks in Japanese yen or US dollars before leaving their own countries.

(i) Access to the Congress Site

On important occasions including the morning of Aug. 21, free bus transportation between major hotels and the Congress Site (KICH) will be provided.

During hours of official programs at KICH as well as in the morning, we plan to run a frequent shuttle bus service between KICH and a stop near "Kitaoji" station, so that participants can use it in conjunction with a subway and the city buses (which run frequently from, to and through Kitaoji Station) to go to KICH from

hotels, from KICH back to hotels or to go to sightseeing spots.

Further information about these free bus services will be included in the Third Announcement and in the Registration Packet.

KICH can also be reached by a city bus as described below.

(i) Local Transportation (Central Kyoto City)

Subway. A municipal subway runs north-south under Karasuma Dori (street). The northern terminal of the subway is "Kitaoji" station. From there, the Kyoto International Conference Hall (the bus-stop "Kokusai Kaikan-mae") can be reached by the free shuttle bus service described in (i) or by a bus No. 北4. (The current bus fare is ¥180 one way. It takes about 15 minutes.)

City buses. Apart from the subway, the bus is the only public transportation to most places in the city. One boards the bus through the back door and gets off through the front door. For buses running only in the central part (recognizable by either the red or blue color of the bus number), the current price is ¥180 per ride. For buses running a longer distance (recognizable by the black color of the bus number), take a slip of paper (available immediately to the left of the entrance) when boarding the bus. This paper indicates the zone number of your boarding point. The fares corresponding to that number are indicated on the panelboard located at the front of the bus. (They increase as the bus moves on.) When you get off the bus, you pay the fare by putting the exact amount and the slip of paper in a box on the side of the bus driver.

Taxi. For a small size taxi, which accommodates up to 4 persons, the initial 2km is ¥470 and each additional 540m is ¥90. (An additional time charge will set in when the taxi is moving slowly.) The distance from the center of town (Shijo-Kawaramachi) to KICH is 8km and normally costs about 1,600. The price goes up about 20% between 11 o'clock at night and 5 o'clock the next morning.

(k) Car Rentals

Rental cars can be booked at the JTB desk. An international driver's license must be carried together with the driving license of the driver's home country. In Japan, vehicles travel on the left (as in England.)

6. Accommodation

(a) Hotels

A large number of rooms have been reserved for the members of ICM-90. The specially discounted room rates (in yen), which include tax and service charges (but no meals), are listed in Table A on page 200.

Hotels in Class A will provide first class accommodation. Hotels in Class B are of good quality but somewhat less luxurious than those in Class A. Hotels in Class C provide adequate and comfortable accommodation. Hotels in Class D provide rooms of compact size but with the necessary facilities.

Accommodation in Class E and Youth Hostels will be on a 3-8 persons sharing basis. There is no private bath either at Tower Restel or Youth Hostels.

Room assignments in hotels will be made for the lowest priced rooms in the category chosen on a first-come, first-served basis.

Accommodation arrangements are handled by the Japan Travel Bureau. To book accommodation, fill in the Accommodation Form (Form C) on pages 211-212 and send it to the JTB Kyoto Office as soon as possible.

A deposit of ¥20,000 per room is required. Payment of the deposit is to be made to the Japan Travel Bureau. The method of payment is described in Form C.

Confirmation of your reservation will be made by the Japan Travel Bureau. Participants who would like to stay in hotels in Class E or youth hostels are requested to choose a representative. Representatives may apply for the accommodation in Application Form C with all the names of persons who will share a room and the deposit of ¥20,000. JTB will send the Confirmation Letter to the representative. JTB will accept only the representative's Application for hotel reservation to avoid a double booking.

(b) Dining (All prices are as of Autumn, 1989)

Numerous restaurants and eating places are found in the center of Kyoto. Inexpensive breakfasts can be found at fast food chain stores and small eating places. Many restaurants close around 21:00.

Lunches at KICH range from ¥800 to ¥1,200. A buffet style lunch (i.e. you can eat as much as you want) will be arranged at the price of ¥1,200. A fixed number of tickets for the buffet lunch will be sold at KICH. Sandwiches will also be sold at KICH for a takeout lunch.

A map of nearby restaurants and eating places will be included in the Registration Packet to be given at the Registration Desk in Kyoto.

7. Registration

(a) Rules

All adults are required to wear a Congress Admission Badge to enter and to remain in the Kyoto International Conference Hall. To obtain a Congress Admission Badge, one must register.

All mathematicians who wish to attend sessions should register as Ordinary Members. Others age 16 or above should register as Accompanying Members. Those under 16 should register as Child Members.

Accompanying and Child Memberships are available only to persons who accompany an Ordinary Member and who do not participate in the scientific activities of the Congress.

Participants should be aware that registration is considered valid until payment has been made and cleared to the ICM-90 account.

All Ordinary Members are entitled to participate in Congress activities and will receive a Registration Packet including a Congress Admission Badge, the program abstracts, etc. at the Registration Desk in Kyoto as well as a complimentary copy of the Proceedings when published.

All Accompanying and Child Members are entitled to participate in all social activities of the Congress. Each Accompanying Member will receive a Registration Packet for Accompanying Members including a Congress Admission Badge and information about social activities of the Congress and about sightseeing in Kyoto.

(b) Preregistration

Complete the Preregistration Form (pages 203-204) and send it to us. (Address on page 188.) Please take note of the following important points:

(i) You are requested to attach a copy of the remittance statement you receive from your bank (or Post Office) to the Preregistration Form so that your payment can be identified and confirmed.

(ii) Registration at reduced rates is applicable if the fee is paid on or before **May 15, 1990**.

(iii) If you wish to present a short communication, an abstract should be sent together with the Preregistration Form and we must receive them before **April 15, 1990**.

(iv) Preregistration of Accompanying and Child Members to be made in conjunction with the preregistration of Ordinary Members.

(v) Write your mailing address on the Acknowledgement Card on page 205 and enclose it with the preregistration documents.

Those who have completed preregistration will receive the Acknowledgement Card. Be sure to bring the card; you will receive the Registration Packet in exchange of this Card at the Registration Desk in Kyoto.

(c) Registration Fees

	On or before May 15, 1990	After May 15, 1990
Ordinary Members	¥ 30,000 *	¥ 40,000
Accompanying Members	¥ 10,000 *	¥ 10,000
Child Members	free	free

* However, see (d) (iii) on the next page.

(d) Remittance

All registration fees must be paid in one of the following four ways:

Please note that bank fees are not included in the registration fee. These must be paid by the participant. Also note the following.

Cash, personal checks, credit cards and bank drafts are unacceptable.

(i) In Japanese yen by bank remittance (ask for "mail transfer" or "wiring" at your bank) to the following account:

Name of the Bank: Kyowa Bank, Shinjuku-nishiguchi Branch
Account Holder (Payee's Name): ICM-90, KYOTO
Account Number: 143-500940.

Address of the Bank: 1-10-1 Nishishinjuku, Shinjuku-ku, Tokyo 163-91 JAPAN

(ii) In some countries, the payment can be made either by a postal money order or by postal (GIRO) transfer into the following postal account through Post Offices instead of (i).

Account Holder: ICM-90, KYOTO
Account Number: Kyoto 2-40872

(iii) For *oversea residents*, if the payment is made on or before May 15, 1990, registration fees may be paid in U.S. dollars by bank remittance or postal money order to the above accounts. (Postal Transfers are not available in the U.S. A postal money order can be sent to the Secretariat.) In this case, the registration fees are \$200 for an Ordinary Member and \$70 for an Accompanying Member. After May 15, the registration fees must be paid in Japanese Yen, ¥40,000 for an Ordinary Member and ¥10,000 for an Accompanying Member.

(iv) Residents in Japan may send the registration fee in Japanese Yen into the above postal account through Post Offices.

(e) Cancellation and additions

Cancellation and/or additions must be made in writing to the Secretariat. Refund of the registration fee for cancellation will be sent by bank remittance to the account specified in the cancellation letter, as follows:

Cancellation by **June 30, 1990**—the amount reduced by bank handling charges and possibly by currency exchange.

Cancellation after **July 1, 1990**—No refund

(f) Registration desk

A Registration Packet will be given to each Ordinary and Accompanying Members at the Registration Desk. On **Monday, August 20, 1990**, a Registration Desk will be open during 13:00–22:30 at the Hotel Keihan, in front of the first Airport but stop in Kyoto and near Kyoto Station. (See 5(b) on page 191.) Free Congress buses will be available from there to hotels. The Congress Admission Badge obtained at the registration entitles you to use these buses.

From **Tuesday, August 21, 1990**, the Registration Desk will be at the main entrance of the Kyoto International Conference Hall.

Important for preregistered participants: Be sure to bring the Acknowledgement Card of Registration sent from us as you will receive the Registration Packet in exchange for this Card. Those who do not receive the Card should bring a proof of payment such as a copy of your bank (or Post Office) remittance statement.

There will be a separate desk for On-Site Registration.

8. Publications

(a) Abstracts

Abstracts received from Plenary and 45-minute speakers and participants presenting Short Communications will be reproduced and distributed to all registered Ordinary Members with their Registration Packet at Kyoto.

(b) Proceedings

All invited addresses and lectures as well as a report of the Congress will be published in the Proceedings of the International Congress of Mathematicians, Kyoto, 1990. The Proceedings will be co-published by the Mathematical Society of Japan and Springer-Verlag, and each registered Ordinary Member of **ICM-90** will receive a complimentary copy.

Additional copies for institutions and non-participant individuals will be available directly from Springer-Verlag. They are available at 20% off the list price, if the order is placed with Springer-Verlag not later than **August 29, 1990** (the last day of the Congress). The order can be placed at the Springer-Verlag booth in the Book Exhibit on the fifth floor of KICH during the Congress.

An alphabetical list of all **ICM-90** Ordinary Members, including their mailing addresses, will be kept at the **ICM-90** Registration Desk throughout the Congress. Ordinary Members are asked to check their own listing for accuracy while they are in Kyoto as this list will be used to prepare the official list of participants for inclusion in the Proceedings and to prepare mailing labels for shipment of the Proceedings in 1991.

(c) Program

All registered Ordinary Members will receive a copy of the official **ICM-90** program of the sessions with their Registration Packet.

(d) List of Participants

A list of preregistrants will be distributed to all Ordinary Members with their Registration Packet in Kyoto.

(e) Lecture Notes and Manuscripts

Lecture notes provided by any speaker prior to his/her talk will be made available to participants. These lecture notes should be given to the **ICM-90** Secretariat. Unfortunately, **ICM-90** does not have facilities for the duplication of notes, so that only the quantity provided by the speaker will be put out for distribution.

(f) Daily News

A newsletter containing program changes, announcements of informal seminars, and information of general interest to ICM-90 participants will be available each morning from **August 21 through August 29** in the Registration Desk area. Participants should plan to pick up a copy every day.

The ICM-90 Secretariat will prepare the Daily Newsletter. Participants with items for the newsletter should be sure to submit them no later than 15:00 the day before.

9. Mail and Messages**(a) Mail**

All mail, cables and telegrams for persons attending the Congress should be addressed to:

Name of the Participant
c/o ICM-90
Kyoto International Conference Hall
Takaraga-ike, Sakyo-ku, Kyoto 606, JAPAN
Telephone: (075) 791-3111
Telex: 5422353 INTHAL J
Fax: (075) 711-1100
Cable: INTHALL KYOTO

These items may be picked up at the mailbox in the ICM-90 registration area.

(b) Personal Messages

Participants wishing to exchange personal messages during ICM-90 should use the mailbox mentioned above. Message pads and pencils are provided. We regret that messages left in the box cannot be forwarded to participants after the Congress is over.

(c) Telephone Messages

To avoid mistakes, only simple messages will be taken and will be placed in the mailbox mentioned above. It will not be possible for ICM-90 Secretariat either to check the presence of a specific person or to check whether the message actually reaches the intended person.

(d) Overseas Telephone, Cables

There are pay telephones in the Kyoto International Congress Hall (KICH). Telephone cards can be purchased at the automatic vending machine next to the pay telephone. Cables can be sent at the Hall Office on the ground floor of KICH.

10. Other Information**(1) Official Languages**

English, French, German and Russian will be the official languages of the scientific programs of the Congress including Abstracts and Proceedings Manuscripts, although no interpreters will be provided. Announcements and other business matters of the ICM-90 will be carried out in English.

(2) Exhibits

The book display will be open on the fifth floor of KICH throughout the Congress period.

(3) Invitation Letters

An official Invitation will be sent by the Organizing Committee upon request. However, this invitation does not include the payment of any expenses, such as registration, travel, or accommodation fees. This request should be sent to the ICM-90 Secretariat.

(4) Climate and Clothing

Kyoto is usually hot and humid in August. The average temperature in August is 27.5° C (81.5° F) and the average humidity is 77%. Accordingly, light and casual clothing is appropriate. The Conference Hall and major hotels are well air-conditioned. A light sweater or cardigan may be useful there. No formal dress will be required on any occasion during the Congress.

(5) Credit Cards

Diners Club, American Express, Visa and Master Charge cards are widely accepted at hotels, department stores, shops, and restaurants as well as by major transportation systems. Other international credit cards have not yet been introduced in Japan. Note that credit cards will not be accepted for payment of the Registration fee of the Congress.

(6) Health and Accident Insurance

The Congress fee does not include insurance for the participants against accidents, sickness, or loss of personal property. All participants are advised to make necessary arrangements for short-term health and accident insurance before departure.

(7) Tipping

Tipping is not customary in Japan.

(8) Electric Current

The electric current is 100V, 60Hz AC in western Japan (e.g., Kyoto) and is 100V, 50Hz AC in eastern Japan (e.g., Tokyo).

List A Complimentary Program for Accompanying Members in KICH

These programs are complimentary. No application is necessary. They are on first-come first-served basis as long as capacity permits. All programs will be in Japanese. The rooms will be announced in the Registration Program for Accompanying Members.

KICH-1 Movies

Date: **Tuesday, August 21, 14:00-15:00**
Wednesday, August 22, 10:00-11:00

This will be to provide information about what is available for sightseeing in Kyoto and Nara.

KICH-2 Kyogen (Japanese comic play) in English
Date: **Thursday, August 23, 10:00-11:00**

One style of traditional drama reflecting everyday and social conditions, often making use of mime and comical situations.

KICH-3 Tea Ceremony
Date: **Friday, August 24 and Monday, August 27**

10:00, 11:00, 13:30, 14:30 and 15:30

This will be held in Hoshooan Tea-ceremony House in the Garden of KICH. Capacity for one session is 35. Free entrance tickets will be available at the Registration Desk on first-come first-served basis.

KICH-4 Origami—the Art of Paper-Folding

Date: **Tuesday, August 21, 15:00-16:30**

Friday, August 24, 10:00-12:00

Participants of this program will learn the Japanese art of folding paper into various shapes and using them as decorations. Other paper works will also be included.

List B Excursions

Sunday, August 26 will be set aside for optional excursions and no lectures will be scheduled on this day. The following Excursions are operated by the Japan Travel Bureau. For application, please fill out the enclosed Form C.

For Ordinary and Accompanying Members, the Organizing Committee will subsidize excursions by deducting ¥3,000 from excursion fee or giving a one-day pass for buses & subway of Kyoto City. Please make a choice and make an application on Form C. *Excursions can also be booked at the Congress* but ¥3,000 support and the one-day pass will not be given in that case.

Pick-up services for these excursions are available from each hotel.

Actual pick-up times will be shown on a ticket which will be handed to you during the Congress.

Fares for children are the same as adults in case the children need their seats. Otherwise, they are free of charge.

EX-1 Kyoto Afternoon Tour (Same as PA-15.)

Date: **Aug. 26 (Sun.)**, Time: 13:00-17:30, Fee: ¥5,000

Hotel—Heian Shrine—Sanjusangendo Hall—Kiyomizu Temple—Hotel

Heian Shrine: is the most representative Shinto Shrine in Kyoto, and is dedicated to Emperor Kammu, the founder of the Kyoto Capital, and Emperor Komei, the last Emperor of the Kyoto Capital.

Sanjusangendo Hall: The present building was reconstructed about the middle of the 13th century, and is regarded as one of the best specimens of architecture of its kind. The temple is also known as the "Temple of Thousand Images" because of its numerous buddhist images.

Kiyomizu Temple: is one of the oldest temples in Kyoto, its origin dating back to the 8th century. Its main hall stands on a cliff, with a wooden platform in front from which a panoramic view of Kyoto can be enjoyed.

EX-2 Nara

Date: **Aug. 26 (Sun.)**, Time: 8:00-17:30, Fee: ¥9,200 (lunch included)

Hotel—Tobihino (Deer Calling)—Kasuga Shrine—Lunch at Nara Hotel—Todaiji Temple—Kofukuji Temple—Hotel

Tobihino (Deer Calling): Hundreds of deer will gather at the caretaker's trumpet-call. This is truly a magnificent scene.

Kasuga Shrine: consists of four small shrines.

Todaiji Temple: boasts of two of the world's largest work of man. One is the Daibutsu or Great Buddha, the largest bronze statue on earth. The other is the Daibutsuden or the Hall of the Great Buddha in which the Daibutsu is enclosed. It is the largest wooden structure made by man.

Kofukuji Temple: founded in Nara in 710 as the tutelary temple of the Fujiwara nobility. A large museum houses some of the finest images of Buddha in Japan, dating from the 7th century through the Kamakura period (1185-1333). The collection is regarded as essential to the study of Japanese culture.

EX-3 Mt. Hiei & Lake Biwa

Date: **Aug. 26 (Sun.)**, Time: 8:15-16:30, Fee: ¥11,700 (lunch included)

Hotel—Enryakuji Temple—Biwako O'hashi Bridge—Lunch at Biwako Hotel—Lake Biwa Cruise—Hotel

Enryakuji Temple: is located atop Mt. Hiei in a thick grove of Japanese cypress-trees.

Biwako O'hashi Bridge: is a 1,350 meters long toll bridge.

Lake Biwa: is the largest fresh-water lake in Japan. Enjoy a delightful cruise on Lake Biwa aboard a large sightseeing vessel called the "Michigan".

EX-4 Rapids Shooting & Arashiyama

Date: **Aug. 26 (Sun.)**, Time: 9:00-16:30, Fee: ¥11,500 (lunch included)

Hotel—Kameoka—Arashiyama—Lunch at Rantei—Tenryuji Temple—Ryoanji Temple—Hotel

Rapids Shooting: is an exciting 16 kilometer, ninety-minute trip downstream, shooting the Hozu Rapids aboard a flat-bottomed boat from Kameoka to scenic Arashiyama.

Arashiyama: is a beautiful spot where one finds within its limited area all the beauties of nature.

Tenryuji Temple: is the headquarters of the Tenryuji school of the Rinzaï sect.

Ryoanji Temple: was founded by Priest Giten under the patronage of Katsumoto Hosokawa in 1448. Its gardens have remained intact, and the temple is especially noted for its five hundred year old rock garden, which contains no trees at all. The garden was constructed around 1450, soon after the founding of the temple. As it contains no plants, it is one of the very few old gardens which can be seen exactly as the designer made it.

List C Program of Accompanying Members (PA)

Persons registered as Accompanying Members may apply for this program. For application, please fill out the enclosed Form C.

Any of the following programs will be cancelled if the number of participants for the program is less than 30 persons.

For Accompanying Members, the Japanese Organizing Committee will subsidize a total amount of ¥2,000 per person for these programs.

Actual pick-up times will be shown on a ticket which will be handed out during the Congress.

A combination of morning, afternoon and night programs on the same day is possible.

Fares for children are the same as adults in case the children need their seats. Otherwise, they are free of charge.

PA-1 Yuzen Dyeing & Pottery Making

Date: Aug. 22 (Wed.), 8:30-12:00, Fee: ¥8,500

Hotel—Kodai-Yuzen-en (Yuzen Dyeing)—Ashahido (Kiyomizu Pottery)—Hotel

Kodai-Yuzen-en: The Kyo-Yuzen process, devised about 300 years ago, is a unique technique for dyeing clothes beautifully. Yuzen (printed silk) is one of representative dyed goods in Japan.

You will also enjoy dyeing your own handkerchief!

Asahido (Kiyomizu Pottery): Kiyomizu-yaki (pottery) is the most popular chinaware produced in Kyoto. You can enjoy making pottery yourself and can observe the various techniques to produce Kiyomizu pottery.

PA-2 Tea Ceremony, Flower Arrangement, Origami Art (paper folding) & Shopping

Date: Aug. 22 (Wed.), 13:00-16:30, Fee: ¥8,300

Hotel—Higashiyama Saihoji (Tea Ceremony, Flower Arrangement and Origami Art)—Kyoto Handicraft Center—Hotel

The tea ceremony: which originated with Sen-no-Rikyu in the 16th century is a ceremony practiced in cultured circles in Japan and is a means of cultivating mental composure and poise. In the ceremony, powdered green tea is whipped with hot water in a special tea bowl and served to participants with Japanese sweet cakes.

Demonstration and practice of flower arrangement: The lesson, in which flowers are arranged in a vase, will be given in the traditional style.

Origami Art (paper folding): The history of Origami dates back so far that it is not quite certain how and when the popular images such as the crane or treasure boat became established. Enjoy making paper images.

Kyoto Handicraft Center: A place to observe exhibitions and demonstrations of Japanese traditional arts and crafts.

PA-3 Japanese Calligraphy and Traditional Arts

Date: Aug. 23 (Thu.), 9:00-12:00, Fee: ¥7,000

Hotel—Kanpo Kaikan (Japanese Calligraphy)—Kyoto Municipal Museum of Traditional Industry—Hotel
Kanpo Kaikan: You can learn the history of Japanese calligraphy and try it by yourself at the Japan Calligraphy Education Foundation.

Kyoto Municipal Museum of Traditional Industry: opened in 1976, exhibits Kyoto's traditional handicrafts and features demonstrations in the actual making of the articles.

PA-4 Kyoto Garden Tour

Date: Aug. 23 (Thu.), 13:00-17:00, Fee: ¥5,200

Hotel—Myoshinji Temple—A Gardener's Residence—Ryoanji Temple—Hotel

Myoshinji Temple (Garden of Taizo-in): The entire area of the garden is covered with nearly 40 species of green and yellow moss, some grown to an unusual thickness, and is world famous for this unique feature seen nowhere else.

A Gardener's Residence: Visit a farmhouse style private home with its traditional kitchen, and its lovely garden.

Ryoanji Temple: See EX-4.

PA-5 Rapids Shooting & Arashiyama

Date: Aug. 24 (Fri.), 8:30-12:00, Fee: ¥7,800

Hotel—Kameoka—Arashiyama—Hotel

Rapids Shooting: See EX-4.

Arashiyama: See EX-4.

PA-6 Japanese Religion and Kimono Show

Date: Aug. 24 (Fri.), 3:00-17:30, Fee: ¥5,500

Hotel—Daitokuji Daisen-in Temple—Nishijin Textile Center—Inaba Cloisonné—Hotel

Daitokuji Daisen-in Temple: founded in 1319 by Abbot Daitoku. Later, Abbot Ikkyu reconstructed it as one of the chief temples of the Rinzaï sect. Karesansui (garden which uses white sand and rocks to symbolize water and lands) is known for its spectacular scenic beauty. You will observe a sermon by the priest.

Nishijin Textile Center: You will enjoy a Kimono fashion show, a demonstration of weaving, and displays of Nishijin fabrics.

Inaba Cloisonné: Cloisonné originated in Central Asia, and was a center of ancient culture. The art came to Japan with Buddhism. Inaba Cloisonné Co., established in 1887, has about 40 years of experience.

PA-7 Traditional Market & Cooking

Date: Aug. 25 (Sat.), 8:30-13:30, Fee: ¥11,000

Hotel—Nishiki Market—Taiwa Cooking School—Hotel

Nishiki Market: Nishiki street in the downtown area is known with many shops for daily necessities. You can find a scene of Japanese life in this shopping street.

Taiwa Cooking School: The Taiwa Cooking School was founded in 1931 by Mr. Tomojiro Tanaka, the father of the current president.

You can enjoy cooking Japanese style cuisine by yourself, then enjoy eating the results!

PA-8 Nara Full-Day Tour

Date: Aug. 27 (Mon.), 8:30-17:30, Fee: ¥11,000 (lunch included)

Hotel—Byodoin Temple—Todaiji Temple—Kasuga Shrine—Deer Park—Lunch at Nara Hotel—Kofukuji Temple—Hotel

Byodoin Temple: is composed of a number of splendid edifices with especially exquisite interior adornments. Its principal attraction is the main hall, the Phoenix Hall, where a magnificent sculpture of the Amitabha is enshrined.

Todaiji Temple: See EX-2.

Kasuga Shrine: See EX-2.

Deer Park: covers 525 hectares. It is noted for the tame deer that roam the park in small groups.

Kofukuji Temple: See EX-2.

PA-9 Mt. Hiei & Lake Biwa

Date: Aug. 28 (Tue.), 8:30-17:00, Fee ¥13,000 (lunch included)

Hotel—Enryakuji Temple—Biwako O'hashi Bridge—Lunch at Lake Biwa—Hamaotsu—Miidera Temple—Hotel

Enryakuji Temple: See EX-3.

Biwako O'hashi Bridge: See EX-3.

Lake Biwa: See EX-3.

Miidera Temple: is the headquarters of the Tendai-Jimon sect, and was founded in 674 in memory of Emperor Kobun.

PA-10 Automobile Factory & Sake Brewery

Date: Aug. 29 (Wed.), 8:30-13:00, Fee: ¥4,900

Hotel—Nissan Motors, Ltd.—Gekkeikan Sake Brewery—Hotel—KICH

Nissan Motors, Ltd.: A factory belonging to one of the leading automobile companies in Japan.

Gekkeikan Sake Brewery: Sake is a traditional Japanese rice wine, produced strictly from moldy rice, steamed rice and water. Sake tasting will take place at the end of the tour.

**After this tour, you can attend the Banquet at KICH.

PA-11 Matsushita & Brewery Company

Date: Aug. 30 (Thu.), 8:30-17:00, Fee: ¥10,000 (lunch included)

Hotel—Matsushita Museum of Technology—Lunch at Moriguchi Prince Hotel—Kirin Brewery Company—Hotel

Matsushita Museum of Technology: Numerous types of developed electric and electronic equipment are exhibited.

Kirin Brewery Company, Limited: The Kirin Brewery company you will visit is the biggest producer of beer in Japan. Beer tasting will take place at the end of the tour.

PA-12 Shoren-in & Gion Corner (Night Tour)

Date: Aug. 23 (Thu.), 18:30-22:00, Fee: ¥8,000 (dinner not included)

Hotel—Shoren-in—Gion Corner—Hotel

Shoren-in: The garden is regarded as one of the best landscape gardens in Kyoto. Enjoy the demonstration of Koto Music and the Japanese tea ceremony.

Gion Corner: The tea ceremony, flower arranging, ancient court music, Kyoto dance by geisha girls and Bunraku puppet drama are all demonstrated here.

PA-13 Japanese Martial Arts & Tempura Dinner (Night Tour)

Date: Aug. 27 (Mon.), 18:30-22:30, Fee: ¥10,500 (dinner included)

Hotel—Seibukan (Japanese Martial Arts Demonstration)—Dinner at Japanese restaurant—Hotel

Seibukan (Japanese Martial Arts Demonstration): You will be thrilled by the exciting demonstrations of JUDO, KARATE, AIKIDO, KENDO, and IAI at teh Seibukan, and still active and authentic dojo, or drill hall.

Tempura Dinner at Japanese restaurant: A delicious combination of shrimp, fish, seaweed and vegetables fried in feather-light batter, TEMPURA is something no visitor to Japan should miss.

PA-14 Kyoto Morning Tour

Date: Daily 8:30-13:00, Fee: ¥5,000

Hotel—Nijo Castle—Golden Pavilion—Kyoto Imperial Palace—Kyoto Handicraft Center—Hotel

Nijo Castle: served as the residence of the Tokugawa Shoguns when they visited Kyoto. The typical style of art of the warrior class which can be observed here, is in clear contrast to that of the Court noblemen.

Golden Pavilion: Yoshimitsu, the third Shogun of the Ashikaga Shogunate, laid out an extensive garden and built a beautiful pavilion toward the end of the 14th century. The pavilion became known as the "Golden Pavilion" or Kinkaku because of its gorgeous gilding.

Kyoto Imperial Palace: was originally built in 794.

(On Sundays, National Holidays, the 2nd & 4th Saturdays and several other days, Higashi-Honganji Temple will be visited instead.)

Kyoto Handicraft Center: See PA-2.

PA-15 Kyoto Afternoon Tour

Date: Daily, 13:00-17:30, Fee: ¥5,000

Hotel—Heian Shrine—Sanjusangendo Hall—Kiyomizu Temple—Hotel

Same as EX-1.

PA-16 Nara Afternoon Tour

Date: Daily, 13:00-18:30, Fee: ¥5,700

Hotel—Todaiji Temple—Kasuga Shrine—Deer Park—Hotel

Todaiji Temple: See EX-2.

Kasuga Shrine: See EX-2.

Deer Park: See PA-8.

Table A HOTEL ACCOMMODATIONS

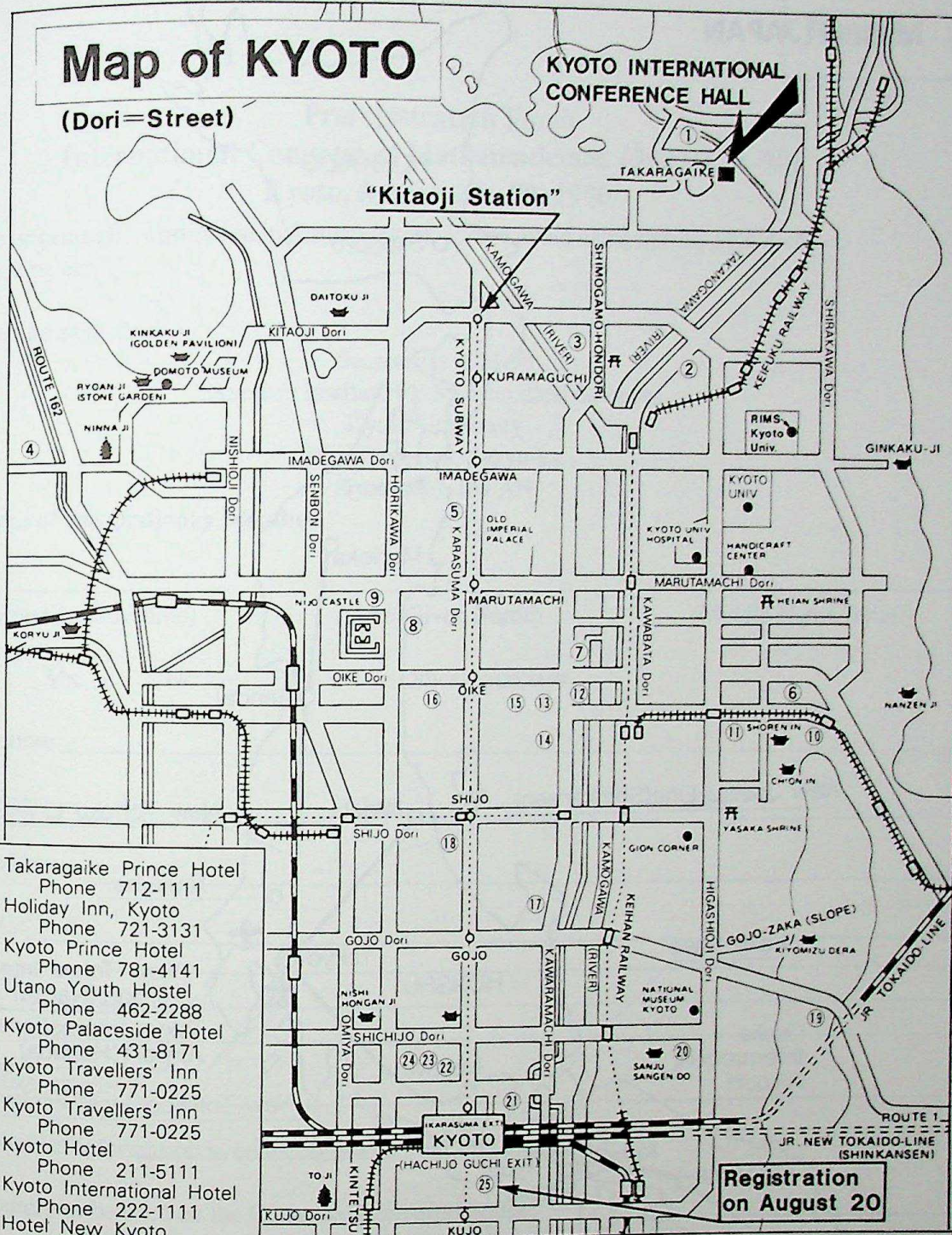
= the number in the map

Class	Name of Hotel	#	Twin	Single
A	a. Takaragaike Prince Hotel	1	¥20,000	*¥13,000
	b. Miyako Hotel	10	¥19,000	*¥12,000
	c. Kyoto Royal Hotel	12	¥18,000	¥10,000
	d. Kyoto International Hotel	8	¥18,000	¥9,000
	e. Kyoto Hotel	7	¥17,000	¥9,000
B	f. Holiday Inn, Kyoto	2	¥14,000	¥8,000
	g. Kyoto Park Hotel	20	¥13,000	¥8,000
	h. Karasuma Kyoto Hotel	18	¥13,000	¥8,000
	i. Kyoto Palaceside Hotel	5	¥12,000	¥8,000
	j. Hotel Keihan Kyoto	25	¥12,000	¥7,500
C	k. Hotel New Kyoto	9	¥11,000	¥7,000
	l. Kyoto Tower Hotel	22	¥11,000	¥7,000
	m. Kyoto Daini Tower Hotel	21	¥11,000	¥7,000
	n. Kyoto Daisan Tower Hotel	24	¥11,000	¥7,000
	o. Hotel Rich	17	¥11,000	¥7,000
	p. Hotel Alpha, Kyoto	13	¥10,000	¥7,000
	q. Sun Hotel, Kyoto	14	¥11,000	¥6,800
	r. Kyoto Garden Hotel	16	¥11,000	¥6,500
	s. Hotel Gimmond	15	¥11,000	¥6,500
	t. Kyoto Prince Hotel	3	¥10,000	¥6,500
D	u. Kyoto Tokyu Inn	19	¥9,000	¥5,500
	v. Kyoto Travellers' Inn	6	¥9,000	¥5,000
**E	w. Kyoto Travellers' Inn	6	4 beds in 1 room with bath ¥3,500/person	
	x. Kyoto Tower Restel	23	4 beds in 1 room with bath ¥3,090/person	
*** Youth Hostel	y. Utano Youth Hostel	4	3 - 8 beds in 1 room without bath ¥2,450/person	
	z. Higashiyama Youth Hostel	11	6 - 8 beds in 1 room without bath Dinner & Breakfast included ¥3,295/person	

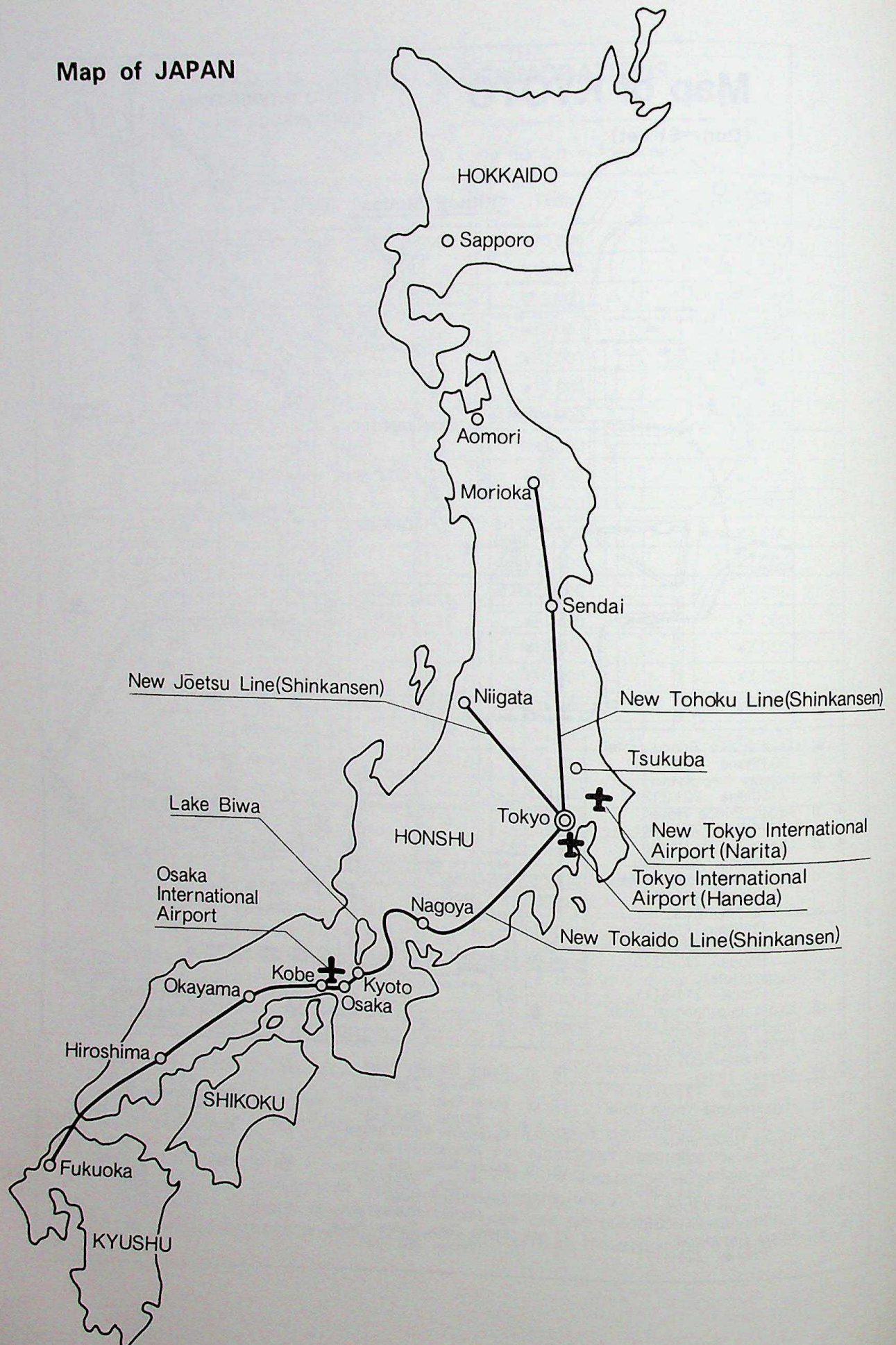
* Single occupancy of twin room.

** If you wish to book a Class E room, please find 3 other people with whom you can share a room, and include their names on the application form (Form C). Only one representative out of 4 room-mates should make the application. (See page 12.)

*** Similarly, if you wish to book a room in a youth hostel, find 2 ~ 7 other people to share a room (3 ~ 8 people in one room) and choose one representative, who should write the name of all other roommates in Form C as Hotel Room-mates and make the application.



Map of JAPAN



Form A

Preregistration Form
International Congress of Mathematicians 1990 (ICM-90)
Kyoto, August 21 - 29, 1990

Please type or print all information in Roman letters. Please avoid using cyrillic alphabets, Chinese Characters, etc.

This Form must be sent to:

Secretariat ICM-90
Research Institute for Mathematical Sciences
Kyoto University
Kitashirakawa, Sakyo-ku
Kyoto 606, JAPAN

A. Personal data of the Ordinary Member.

Name: _____
(Last=Family=Surname) (First=Given Name) (Middle Name/Initial)

Title: Mr. Ms. Dr. Prof. Others (Specify):

Name of Institution: _____

Telephone: _____ Fax: _____ Telex: _____

Email address: _____

Mailing Address: _____

Nationality (Citizenship): _____

(We will need correct information in connection with your visa application.)

Name of the country to be used on the Congress Admission Badge: _____

B. Accompanying Members

Number of Accompanying Members: _____

Name(s): 1. _____
(Last=Family=Surname) (First=Given Name) (Middle Name/Initial)
2. _____
(Last=Family=Surname) (First=Given Name) (Middle Name/Initial)

C. Child Members

Number of Child Members: _____

Name(s): 1. _____ (Last=Family=Surname) (First=Given Name) (Middle Name/Initial) (Age)
 2. _____ (Last=Family=Surname) (First=Given Name) (Middle Name/Initial) (Age)

D. Short Communication (Deadline: April 15, 1990)

1. I ☐ wish to contribute a short communication
 I ☐ do not wish to contribute a short communication

2. Abstract of Short Communication is enclosed (in case you wish to contribute)
☐ yes
☐ no because _____

E. Number of members from your party participating in social events

	reception	performances musical	concert	banquet
Ordinary Members				
Accompanying Members				
Child Members				

F. Registration Fee

	on or before May 15, 1990	After May 15, 1990	To be sent before May 15
Ordinary Member	<input type="checkbox"/> ¥ 30,000	<input type="checkbox"/> ¥ 40,000	<input type="checkbox"/> U.S. \$200
Accompanying Members	¥ 10,000 x _____ persons = _____		US \$70 x _____ persons = _____
Total	¥ _____		U.S. \$ _____

The method of payment: as explained in the copy of the enclosed bank statement.
 (If proof of payment is not enclosed, please explain the situation in exact detail.)

G. Special Requests

Acknowledgement Card
International Congress of Mathematicians 1990
August 21 - 29, 1990 Kyoto, Japan

The secretariat acknowledges receipt of

- | | |
|---|--|
| <input type="checkbox"/> your preregistration | <input type="checkbox"/> your abstract |
| <input type="checkbox"/> with a proof of payment | <input type="checkbox"/> in good order |
| <input type="checkbox"/> without a proof of payment | <input type="checkbox"/> resubmission required |

You will be notified of the acceptance/rejection of your short communication and the date of presentation in due course.

Date received:

Reg. No.

Please indicate your Reg. No. in any further correspondence.

Acceptance-Rejection Card
International Congress of Mathematicians 1990
August 21 - 29, 1990 Kyoto, Japan

Your abstract entitled _____

has been ☐ accepted in the section _____
☐ not accepted

Reg. No.

Date:

Tentative	Aug.	Aug.	Aug.	Aug.	Aug.
Schedule	22	23	24	27	28

****IF AT ALL POSSIBLE, USE THE CARDS PROVIDED IN THE OFFICIAL
ICM-90 SECOND ANNOUNCEMENT**

The Forms are to be enclosed with a completed Preregistration Form.
If you are applying for a Short Communication, please enclose both cards.
Otherwise, enclose only the Acknowledgement Card.
Do not forget to write your name and address on the other side of the cards.

POST CARD

STAMP

Secretariat ICM-90
Research Institute for
Mathematical Sciences
Kyoto University
Kitashirakawa, Sakyo-ku
Kyoto 606, Japan

To Name:
Address:

Country:

Air Mail

POST CARD

STAMP

Secretariat ICM-90
Research Institute for
Mathematical Sciences
Kyoto University
Kitashirakawa, Sakyo-ku
Kyoto 606, Japan

To Name:
Address:

Country:

Air Mail

Instruction for preparation of abstracts

(i) Each abstract should be typewritten (or of letter quality if a computer printer is used) on good quality, heavy, white paper, using black ribbon. If symbols are added by hand, black ink must be used. It should be in a form ready for photographic reproduction.

(ii) The typed portion must be within a rectangle 20cm (width) x 10cm (height) (8" x 4").

(iii) Name, affiliation, country and title should be typed single-spaced on the first lines, as in the following example:

*Newton, Isaac, Cambridge Univ., United Kingdom,
Theory of the Moon's Motion*

(iv) A classification of the subject according to the 18 sections listed on page 189 should be given at the top of the page *outside* the rectangle containing the text of your abstract. In some cases, we might change the section of

your talk so that related talks are presented in the same session. Thus the Section in the acceptance card may be different from your selection of sections.

(v) In case of joint authorship, the presenter's name should appear outside the rectangle.

N.B. If the abstract does not conform to the above rules, it will be returned to the author for resubmission.

Please refer to the example on page 208. In photographic reproduction, the size will be reduced to 70%. Thus the example on p. 208 will be reduced to the following size.

NEWTON, Isaac, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, Silver Street, Cambridge, CB3 9EW, UK and GAUSS, Carl F., Faculty of Mathematics, University of Göttingen, 6400 Göttingen, FRG.—Theory of the Moon's Motion.

The irregularity of the Moon's Motion has been all along the just complaint of astronomers; and indeed we have always looked upon it as a great misfortune that a planet so near us as the Moon is, and which might be so wonderfully useful to us by her motion, as well as her light and attraction (by which our tides are chiefly occasioned) should have her orbit so unaccountably various, that it is in a manner vain to depend on any calculation of an eclipse, a transit, or an appulse of her, tho never so accurately made.....

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P.O. Box 6248
Providence, Rhode Island 02940-6248

If you have not already done so, be sure to mail your request to continue receiving UME TRENDS.

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We hope you enjoyed the first issues of **UME TRENDS** and found the articles helpful. Future plans for the publication depend on the number of people requesting **UME TRENDS**, so please respond today.

Ed Dubinsky, Editor
UME TRENDS

10 cm = 4 inches

Section = 13

Presenter = Newton

NEWTON, Isaac, Department of Applied Mathematics and Theoretical Physics, University of Cambridge, Silver Street, Cambridge, CB3 9EW, UK and GAUSS, Carl F., Faculty of Mathematics, University of Gottingen, 6400 Gottingen, FRG., - Theory of the Moon's Motion -

The irregularity of the Moon's Motion has been all along the just complaint of astronomers ; and indeed we have always looked upon it as a great misfortune that a planet so near us as the Moon is, and which might be so wonderfully useful to us by her motion, as well as her light and attraction (by which our tides are chiefly occasioned) should have her orbit so unaccountably various, that it is in a manner vain to depend on any calculation of an eclipse, a transit, or an appulse of her, tho never so accurately made.....

20 cm = 8 inches

Form B

Abstract Form for Short Communications
(For remittance, see page 189)

Presenter =

Section =

Do not fold. Protect surface from damage.

***IF AT ALL POSSIBLE, USE THE FORMS PROVIDED IN THE OFFICIAL**

ICM-90 SECOND ANNOUNCEMENT

THE INTERNATIONAL CONGRESS OF MATHEMATICIANS 1990
KYOTO, JAPAN
August 21 - 29, 1990

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FORM C

ACCOMODATIONS AND TOUR APPLICATION FORM

INTERNATIONAL CONGRESS OF
MATHEMATICIANS
Kyoto, Japan, August 21 - 29, 1990

Return this form by June 30, 1990 to
JAPAN TRAVEL BUREAU
Kyoto Office, ICM-90 Dept.
Higashi-shiokoji-cho
Shimogyo-ku, Kyoto 600, Japan

Type or print in BLOCK LETTERS

Name :			
Prof. / Dr. / Mr. / Mrs. / Ms. _____			
(Family Name)		(First Name)	(Middle Initial)
Affiliation : _____			
(University, Company, etc.)			
Address : _____			
(Street)		(City)	
<input type="checkbox"/> Office			
<input type="checkbox"/> Home			
(Province/State)	(County)	(Postal Code)	
(Telephone)	(Telex)	(Facsimile)	
Accompanying Person(s) :			
(Family Name)		(First Name)	
_____		_____	
_____		_____	

PAYMENT: Total Amount ¥ _____ (Details on the reverse side)

- ☐ I enclose herewith a bank draft, covering the above total, payable to the order of the Japan Travel Bureau, Inc. (Personal checks will not be accepted.)
- ☐ I would like to pay the above total by Credit Card. (Please fill in the following form.)

Record of Charges

Total Amount : ¥ _____

Name of Card : Diners/Master/Visa/Amex (Circle one)

Cardmember Account No. : _____

Valid Dates: _____

Cardmember Signature : _____

Payment or proof of payment should accompany this form. If it is impossible to send fees beforehand, please attach a letter to this form, explaining the reason.

Your Address for further Correspondence

Please print or type your name and mailing address in the space above. It will be used for further correspondence.

Date : _____ Signature: _____

(This application will be valid upon your receiving confirmation from JTB.)

HOTEL ACCOMMODATIONS

1st Choice:
2nd Choice:

No. of Twin Rooms: _____

No. of Single Room: _____

Hotel Deposit: _____

Check-in: Aug. _____, 1990

Check-out: Aug. _____, 1990 = _____ night(s)

room(s) X ¥20,000 = ¥ _____ (a)

Hotel Room-mates (In case of Class E Hotels and Youth Hostels)

EXCURSIONS (EX)

Aug. 26(Sun)	EX-1	Kyoto Afternoon Tour	¥5,000 X _____ person(s)	¥ _____
Aug. 26(Sun)	EX-2	Nara	¥9,200 X _____ person(s)	¥ _____
Aug. 26(Sun)	EX-3	Mt. Hiei & Lake Biwa	¥11,700 X _____ person(s)	¥ _____
Aug. 26(Sun)	EX-4	Rapids Shooting & Arashiyama	¥11,500 X _____ person(s)	¥ _____

Subtotal : ¥ _____ (b)

☐ I prefer to have a deduction from the tour ¥3,000 X _____ person(s) ¥ _____ (c)

☐ I prefer to have a One-Day pass of buses and subway _____ person(s)

(b) - (c) ¥ _____ (d)

PROGRAMS FOR ACCOMPANYING MEMBERS (PA)

Aug. 22(Wed)	PA-1	Yuzen Dyeing & Pottery Making	¥8,500 X _____ person(s)	¥ _____
Aug. 22(Wed)	PA-2	Tea Ceremony, Flower Arrangement, Origami Art & Shopping	¥8,300 X _____ person(s)	¥ _____
Aug. 23(Thu)	PA-3	Japanese Calligraphy & Traditional Arts	¥7,000 X _____ person(s)	¥ _____
Aug. 23(Thu)	PA-4	Kyoto Garden Tour	¥5,200 X _____ person(s)	¥ _____
Aug. 24(Fri)	PA-5	Rapids Shooting & Arashiyama	¥7,800 X _____ person(s)	¥ _____
Aug. 24(Fri)	PA-6	Japanese Religion & Kimono Show	¥5,500 X _____ person(s)	¥ _____
Aug. 25(Sat)	PA-7	Traditional Market & Cooking	¥11,000 X _____ person(s)	¥ _____
Aug. 27(Mon)	PA-8	Nara Full-Day Tour	¥11,000 X _____ person(s)	¥ _____
Aug. 28(Tue)	PA-9	Mt. Hiei & Lake Biwa	¥13,000 X _____ person(s)	¥ _____
Aug. 29(Wed)	PA-10	Automobile Factory & Sake Brewery	¥4,900 X _____ person(s)	¥ _____
Aug. 30(Thu)	PA-11	Matsushita & Brewery Company	¥10,000 X _____ person(s)	¥ _____
Aug. 23(Thu)	PA-12	Shoren-in & Gion Corner (night)	¥8,000 X _____ person(s)	¥ _____
Aug. 27(Mon)	PA-13	Japanese Martial Arts & Tempura Dinner (night)	¥10,500 X _____ person(s)	¥ _____
Aug. _____	PA-14	Kyoto Morning Tour (Fill in date!)	¥5,000 X _____ person(s)	¥ _____
Aug. _____	PA-15	Kyoto Afternoon Tour (Fill in date!)	¥5,000 X _____ person(s)	¥ _____
Aug. _____	PA-16	Nara Afternoon Tour (Fill in date!)	¥5,700 X _____ person(s)	¥ _____

Subtotal : ¥ _____ (e)

Support from the Congress ¥2,000 X _____ person(s)* ¥ _____ (f)

(e) - (f) ¥ _____ (g)

* The number of accompanying persons participating in PA.

Total (a) + (d) + (g) = ¥ _____

*The number of accompanying persons participating in PA.

The Accidental Mathematician

Michael Albertson*

The Organizing Committee of the International Congress has earned our gratitude. They amply document a carefully planned event; however, a little more information might increase your enjoyment. Here is some of what I would tell my friends about going to Kyoto.

Invest a little time now. **First**, pick up some language. Before our first visit to Japan we took an evening course (twice a week for ten weeks). Even that miniscule amount offered us opportunities that were not available to typical tourists. As an alternative there are some language tapes that are commercially available. We have been satisfied with Japanese, Module 1 [Advanced Memory Research]. Practice listening and speaking while commuting. Together with the above obtain a copy of *Everyday Japanese* [Schwarz and Ezawa, Passport Books]. It is superb.

Second, learn something about Kyoto. *Kyoto, a Contemplative Guide* [Mosher, Tuttle] is on everyone's short list of what to read about the city. Although its details (prices, transportation, hours, etc.) are outdated, the historical descriptions are vivid. There are a number of guidebooks available but we have not discovered one to recommend without reservation. For example *Kyoto, Seven Paths to the Heart of the City* [Durstun, Kodansha] contains excellent photographs and suggestions for walks, but its details and maps are too often inaccurate.

Third, learn something about the rest of Japan. If you have the time, money, and inclination, there is much to see not too far from Kyoto. There are numerous Guide books: Japan Solo may be slightly better than most. Tokyo is an especial favorite of mine, and *Discover Shitamachi* [Enbutsu, Shitamachi Times] is the best way to find out about it. If you are considering travel around Japan, look into a Japan Rail pass. For a little more than the round trip cost from Tokyo to Kyoto on

the Shinkansen you can purchase a week of free rail transportation.

Finally immerse yourself in all things Japanese. Your library will have Japanese fiction in translation: your video store will have movies to rent: CNN has a weekly news program on Japan. Practice eating with chopsticks.

Most of the remainder of this article is meant to be read in parallel with the second announcement. For ease of reference, the numbering scheme is the same.

5a. The Kyoto International Conference Hall is located in what we would call the suburbs of Kyoto. Although the design is based on that of ancient Buddhist temples, the scaling and the materials cause the building to remind me of a sci-fi starship. However, its setting is congenial. Immediately behind the center, there is a park with several trails and a lake where rental boats are available.

5b. The tourist bureau gives out an excellent map of Kyoto. It shows major sites and transportation lines in English as well as Kanji. Thus if you show it to a taxi driver, he will be able to read it as well. They also publish (in English) a monthly Visitor's Guide. If these are not available at the registration desk at the Keihan Hotel then you can obtain them at the Tourist Information Center. This is located on the west side of Karasuma-dori just north of the station. This center is open during standard Japanese business hours; the staff is both exceedingly helpful and fluent in English.

5h. You will probably need yen for such items as ground transportation immediately after arrival, but do not buy a lot in the United States. The "spread" at U. S. banks (the difference in the price to buy and sell yen) is likely to be several times that of a Japanese bank. It will take some time to change dollars or traveler's checks in a Japanese bank: you fill out currency exchange forms and hand them over together with your dollars or checks at the counter, then sit until your number or name is called indicating that your cash is ready. The rates at hotels will not be quite as attractive as at Japanese banks.

5i. The free bus service provided by the conference sounds excellent. Should you want to travel from the Conference Center to Kitaoji when a bus is not available,

*EDITOR'S NOTE: Michael Albertson is a professor of mathematics and computer science at Smith College, Northampton, MA 01063, albertson@smith.bitnet. Last spring he spent a sabbatical as a visiting scholar at Doshisha University in Kyoto. He and his wife and three children lived in Iwakura, less than a kilometer from the Conference Center. He and Joan Hutchinson have recently co-authored the book *Discrete Mathematics with Algorithms*, John Wiley & Sons, Inc.

a taxi would hold four and cost about 1000 yen.

5j. Subway. To ride on the subway, purchase a ticket at a vending machine in the station. The amount of the fare will depend on the distance you want to travel. Some machines will change 1000 yen notes: all will change coins. There are large subway maps with fares above the vending machines. Insert your ticket in one of the machines at the gate. Watch someone to see where. Be sure to pick your ticket up at the other end of the machine, since you will need it to get out of the station where you get off.

5j. City buses. When you get on a bus, work your way towards the front so you can be ready to get off. Take a seat if one is available. The gray colored seats near the front on the left are reserved for senior citizens. The buttons located next to the seats and overhead signal the driver to stop at the next stop. Bus drivers tend not to answer questions. Note that the buses have a machine next to the driver that will change a 1000 yen note as well as various coins. The drivers can also give you small change (e.g. 20 yen if you put two 100 yen coins in the machine when the fare is 180 yen). There is a recorded voice that announces popular tourist stops in English.

5j. Taxi. The left rear door opens automatically.

5k. I do not recommend attempting to drive in Japan unless you read Kanji and are used to driving on the left side of the road.

6a. The Takaragaike Prince is across the street from the conference center and looks pretty fancy from the outside. The Miyako is a Kyoto landmark. In general, hotel rooms in Japan are smaller than their counterparts in the U. S., but equipped with more gadgets. A pot to make hot water for tea seems to be standard. The hotel will provide (green) tea bags. If you are a coffee addict you might want to bring a jar of instant coffee.

6b. Kyoto is an international city and, as you might expect, has a wide variety of eating establishments. Numerous restaurants serve western style food; however, the preparation tends to be indifferent and the prices high. Chinese restaurants are plentiful but you can probably get better Chinese food in this country. We ate out often, at small restaurants, fancy restaurants, hotels, and street vendors; and we had only one awful experience - the restaurant was trying to be Swiss. My principal advice is to eat Japanese.

There are small Japanese restaurants all over the city. Most have glass cases with plastic copies of the dishes on the menu and their prices. You don't need to know the name of anything: pointing suffices. The set meals, "teishoku" (tay-show-koo), tend to be a good value. Usually these have rice, soup, and a small saucer of pickled vegetables accompanying the main dish. Stuff on noodles (sometimes cold) is also popular. Note that the rice is of the short grained variety: it will seem somewhat sticky. My favorite lunch (take out) was a box

of sushi - for 600 yen there would be about a dozen pieces. Expect to pay anything above 1000 yen for dinner in a Japanese restaurant. If it looks fancy, the price will be astronomical. Skip dessert. Expensive restaurants will automatically add a service charge to the bill: reasonable ones include it in the price. Don't tip.

There are several alternatives for breakfast. Small restaurants will offer what is called a morning set consisting of a boiled egg, toast and coffee (no refills): this might cost 400 yen. The major hotels also offer a breakfast buffet. For perhaps 1500 yen, you can serve yourself eggs, fruit, toast, juice, coffee, as well as rice, fish, soup, and other Japanese delicacies. Finally, Japanese bakeries are excellent: I recommend croissant, baguette, and many of the pastries. Here the etiquette is to pick up a tray and a pair of tongs when you enter, select what you want with the tongs, and take it to the cashier, who will wrap it. If you pick up something that is heavier than you expect, put it back. It is probably filled with brown bean paste called "an" (ahn): an acquired taste.

Kyoto is filled with coffee shops. They are places to sit and read or talk. The coffee tends to be strong, served in small cups, and cost 400 yen or more. If you are there at meal time, you won't be rushed. There are many familiar fast food chains. McDonalds has recognized the same food with reasonable prices. If you have a craving for pizza, practice abstinence. Vending machines are more common than here and have a greater variety of both hot and cold items. Canned sodas are 100 yen but don't expect sugar-free.

7d. As this is being written, the better deal is to pay for registration in dollars. This will remain true as long as the value of the dollar is below 150 yen. I recommend a Postal money order sent directly to the Secretariat (cost will be \$3).

9d. Telephones in Japan are easy to use, and phones are readily available, though some only accept NTT phone cards. Calling the U.S. from Japan is more expensive than in the opposite direction.

10(5). Japan is much more of a cash society than we are. Credit cards are not as widely accepted as this paragraph suggests. You can buy a lot with plastic but you will need cash for admissions as well as for restaurants and merchants who do not specially cater to tourists.

Sightseeing. During your stay in Kyoto, you probably want to see some of the major temples, shrines, gardens, etc. The tours suggested in the second announcement, run by the Japan Travel Bureau, are likely to be well organized, informative, and relatively comfortable (air conditioned busses, etc.) On the other hand, the schedule will be inflexible, and you will not have the opportunity to explore on foot, which is one of the greatest pleasures. If you travel in a small group and use public transport and taxis, you should be able to

your own tour for less money. A clerk in your hotel will write your various destinations for you in Kanji, should you get hopelessly lost. The dangers you expect in a large city here are virtually nonexistent in Kyoto. It is a good idea to carry small packs of tissues since paper is not usually available in public restrooms. A small cloth to dry your hands after washing is similarly recommended. While Japanese-style toilets are still common, western-style are almost always available.

EX-1. The Heian Shrine and Kiyomizu are two must-see sights. The former, including its garden, takes about an hour to explore. The temple compound at Kiyomizu is only part of the reason for a visit here. The nearby streets, especially the Sannenzaka, comprise a historic preservation district. One can easily spend several hours here. From Kiyomizu it is mostly downhill towards the city. I would pass on the Sanjusangendo.

EX-2. Todaiji temple and its Daibutsu are impressive. You can easily arrange your own excursion to Nara by train.

EX-3. Mt. Hiei rises about 850 meters above northeastern Kyoto. It is the dominant geographical feature near the conference center. One can get to the top by hiking or by taking a cable car. The station is just a short cab ride from the conference center. There are temples, huge cypress trees, and a rotating observation deck. Smog frequently obscures an otherwise outstanding view.

EX-4. I have never done the rapids to Arashiyama, but friends highly recommend it. The stone garden at Ryoanji is justly famous, though it will probably be very crowded on a Sunday afternoon.

Program for Accompanying Members. Some of the listed programs include an introduction to various Japanese crafts. I don't feel qualified to comment on how rewarding such a trip might be.

PA-2,3,6. Certainly the Museum of Traditional Industry, the Kyoto Handicraft Center, and the Nishijin Textile Center are worth a visit - good things to do on a rainy day.

PA-7. Visiting a traditional Japanese market such as Nishiki is fascinating: wandering through a supermarket or the basement food section of one of the large department stores would be an interesting contrast. Nishiki is not far from the intersection of Sanjo and Kawaramachi. Also nearby are Daimaru, my favorite department store; Maruzen, a bookstore with a surprisingly large collection of titles in English (upstairs); and Teramachi, a covered pedestrian street full of souvenir shops. A visit here can be combined with an early evening stroll through the Gion section.

PA-12. The gardens and screens at Shoren-in are lovely. The first time we visited Kyoto we went to Gion Corner and were not impressed.

PA-14. Nijo Castle is a favorite. This could be combined with Daitokuji. Instead of the Golden Pavilion

(Kinkakuji) try the Silver (Ginkakuji). The gold on the former is garish, while the gardens at the latter are exquisite. Ginkakuji is less than fifteen minutes by number 5 bus from the Conference Center. Skip the Imperial Palace, though the grounds are a nice place for a picnic.

The planned excursions visit most of the famous Kyoto sights. There is one half-day trip that would make an excellent addition. Northeast of Kyoto, past Mt. Hiei is the rural village of Ohara. This is accessible by city bus from a stop not too far from the Conference Center. Ohara contains a number of ancient temples. At Sanzen-in, the most famous, you will be required to trace some calligraphy (this is a tax dodge) as well as pay a stiff admission fee. The grounds are sublime. For those travelling with children, the movie village Eigamura in the western part of Kyoto is likely to be a big hit.

Savoir Faire. If you are planning on visiting a Japanese mathematician at his or her university or perhaps enjoying a social occasion together during the conference, bring a small something that represents your hometown or institution. A small picture book would suffice - anything typical would be appropriate. An invitation to a Japanese home is considered a great honor: it is much more common to entertain visitors at a restaurant. Should you receive such an invitation, take flowers at least. When we invited Japanese visitors to our house, they, as often as not, brought an entire meal's worth of food with them.

Souvenirs. Consider before you go what you might want to bring back. The items that we typically identify as Japanese (electronics, cameras, etc.) are likely to be much more expensive than in your local store. For example, a videocamera in Kyoto might be twice the price that Sears sells it for. Of course there are some such things that you can buy in Japan that you can't buy here: we brought friends a heated toilet seat. On this trip I plan on bringing back an automatic rice cooker. Our favorite souvenirs from Japan are silks, ceramics, and art. Forget buying a new silk kimono: they are interesting to price. You can get antique haori coats and kimono at Nishimura on Furomonzen in the Gion section. A man's black silk haori coat with an elegant ukiyo-e lining might cost 15000 yen: without the lining, maybe a third of that. A woman's haori or kimono might even be cheaper, depending on the style and condition. For widely available souvenirs such as paper fans, t-shirts, cotton yukata, and lacquer chopsticks, prices and quality will vary depending on where you buy. Hotel gift shops are likely to be expensive. Consider ticket prices as fixed, i.e. do not attempt to bargain.

Assuming that you have done your homework, the best advice I can offer is to be adventurous. Try anything - go anywhere. The Japanese will be extraordinarily helpful, kind, and generous.

Mathematical Sciences Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

EFFECTIVE with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.

1989-1990. **Academic Year Devoted to Hyperbolic Geometry and Quasiconformal Mappings**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1988, p. 1584)

1989-1990. **Special Year in Geometry**, University of Maryland, College Park, MD. (Dec. 1989, p. 1432)

1990. **IMACS International Workshop on Massively Parallel Methods in Computational Physics**, Boulder, Colorado.

(Sep. 1989, p. 914)

1990. **IMACS Conference on Computer Aided Design**, Yugoslavia. (Sep. 1989, p. 914)

*1990. **CWI-IMACS Symposia on Parallel Scientific Computing**, Amsterdam, The Netherlands.

ORGANIZING COMMITTEE: H.J.J. teRiele (CWI), Th. J. Dekker (Univ. of Amsterdam), H.A. van der Vorst (Univ. of Delft).

INFORMATION: H.J.J. teRiele, Dept. of

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Numerical Math., Stichting Mathematisch Centrum, Centrum voor Wiskunde en Informatica, Kruislaan 41098 SJ Amsterdam, The Netherlands.

1990-1991. **Academic Year Devoted to Operator Theory and Complex Analysis**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1989, p. 1432)

March 1990

1-4. **Mathematicians and Education Reform Network**, Ohio State University, Columbus, Ohio. (Nov. 1989, p. 124)

4-10. **Interval Methods for Numerical Computation**, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

5-7. **SIAM Conference on Applied Probability in Science and Engineering**, Orleans, LA. (Nov. 1988, p. 1389)

5-7. **Symposium on Symbolic Computation (on the occasion of the sixtieth birthday of Erwin Engeler)**, Zürich, Switzerland. (Sep. 1989, p. 915)

5-9. **Bifurcations Dynamiques**, Marseille, France. (Jan. 1990, p. 53)

*9-11. **Sixth Annual Geometry Festival**, University of Maryland, College Park, MD.

INVITED SPEAKERS: M. Gromoll, Schoen, S.-T. Yau.

INFORMATION: P. Green, 301-4800, psg@julia.umd.edu; H. Gromoll, 215-898-8178; D. Gromoll, 301-8286; K. Grove, Mathematics Department, Univ. of Md., College Park, 20742, 301-454-7075; H. King, 301-454-7068, hck@athena.umd.edu; J. Wolpert, 301-454-7068, saw@athena.umd.edu; J.Y. Wang, 454-3275.

11-17. **Mathematische Stochastik**, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

12-16. **Twist Mappings and Their Applications**, Minneapolis, MN. (Nov. 1989, p. 1248)

13-16. **Twenty-first Annual International Mathematics Conference**, Isfahan, Iran. (Jul./Aug. 1989, p. 26)

14-19. **East European Category Theory**, Plovdiv, Bulgaria. (May/June 1990, p. 601)

15-21. **International Conference on**

Differential Equations and Mathematical Physics, University of Alabama at Birmingham, Alabama. (Oct. 1989, p. 1094)
16-17. **Central Section Meeting of the AMS**, Kansas State University, Manhattan, KS.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

16-18. **Conference on Stochastic Flows**, University of North Carolina at Charlotte, NC. (Dec. 1989, p. 1434)

18-24. **Masstheorie**, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

18-24. **Third Centenary Celebration of the Mathematische Gesellschaft in Hamburg**, Bundesstraße, Hamburg. (Oct. 1989, p. 1094)

19-22. **Eleventh Annual National Graphical Association Conference and Exposition**, Anaheim, CA. (Jul./Aug. 1989, p. 766)

19-24. **US-USSR Approximation Theory Conference**, University of South Florida, Tampa, FL. (Jul./Aug. 1989, p. 766)

19-April 13. **Mathematical Physiology and Differential-Delay Equations**, Minneapolis, MN. (Nov. 1989, p. 1248)

20-23. **Directions in Matrix Theory**, Auburn, AL. (May/Jun. 1989, p. 601)

*23. **Twelfth N.M. Riviere Memorial Lecture**, University of Minnesota, Minneapolis, MN.

INVITED SPEAKER: Jürgen Moser.

INFORMATION: E. Fabes, School of Mathematics, University of Minnesota, Minneapolis, MN 55455, 612-625-9365.

23-24. **Southeastern Section Meeting of the AMS**, University of Arkansas, Fayetteville, AR.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 0240.

23-24. **University of Arkansas' Fourteenth Annual Lecture Series in Mathematical Sciences**, Univ. of Arkansas, Fayetteville, Arkansas. (Oct. 1989, p. 1095)

25-31. **Kontinuumsmechanik der Festen Körper**, Oberwolfach, Federal Republic of Germany. (Mar. 1989, p. 315)

26-27. **Disorder in Physical Systems**, Mathematical Institute at Oxford University, England.

INFORMATION: G.R. Grimmett, School of Mathematics, University Walk, Bristol BS8 1TW; email: grimmett@npl.a.bristol.ac.uk or D.J.A. Welsh, Merton College, Oxford, OX1 4JD.

26-29. **Workshop on Number Theory and Algorithms**, Berkeley, CA. (Sep. 1989, p. 916)

26-April 6. **Workshop on Group Theory from a Geometrical Viewpoint**, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 601)

28-29. **Chaos in Praxis: The Application of Nonlinear Dynamics in Social Realms**, Battelle Conference Center, Seattle, WA. (Nov. 1989, p. 1249)

29-31. **Modern Perspectives of Mathematics: Mathematics in Academia, Mathematics as a Consumer Good**, Cornell University, Ithaca, NY. (Nov. 1989, p. 1249)

30-31. **Illinois Number Theory Conference**, Urbana, IL. (Jan. 1990, p. 53)

April 1990

1-3. **Low Dimensional Dynamics**, University of Maryland at College Park. (Jan. 1990, p. 54)

1-4. **ENAR Spring Meeting**, Baltimore, MD. (Jul./Aug. 1989, p. 766)

1-7. **Design and Codes**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

1-14. **NATO Advanced Study Institute on "Generators and Relations in Groups and Geometries"**, Castelvecchio Pascoli (Lucca), Italy. (Sep. 1989, p. 916)

3-4. **Mathematics in a Changing Culture**, Glasgow College, Glasgow, Scotland. (Jan. 1990, p. 54)

3-5. **Forty-second British Mathematical Colloquium**, University of East Anglia, Norwich, Norfolk, England. (Jan. 1990, p. 54)

4-7. **Symposium on Distributions with Given Marginals (In Memory of Giuseppe Pompilj)**, Rome, Italy. (Oct. 1989, p. 1095)

5-7. **Twenty-fourth Annual Spring Topology Conference**, Southwest Texas State Univ., San Marcos, TX. (Nov. 1989, p. 1249)

5-8. **Conference on Algebraic K-theory and Algebraic Number Theory**, Johns Hopkins Univ., Baltimore, MD. (Jan.

1990, p. 54)

7-8. **Eastern Section Meeting of the AMS**, Pennsylvania State University, University Park, PA. (Note change in date from Oct. 1989, p. 1095)

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

*7-8. **1990 Association for Symbolic Logic Spring Meeting (in conjunction with a Spring meeting of the AMS and a MAMLS meeting)**, Pennsylvania State University, University Park, PA. (Please note changes from Nov. 1989, p. 1249)

INVITED SPEAKERS: L. Lipshitz, A. Pheidas, H. Friedman, S. Lang, L. van den Dries.

8-12. **Gamm-Jahrestagung**, Hannover, Federal Republic of Germany. (Jan. 1990, p. 54)

8-14. **Arbeitsgemeinschaft Mit Aktuellem Thema (wird in den Mitteilungen der DMV Heft 1/1990 bekanntgegeben)**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

9-13. **Fifth Workshop on Mathematical Aspects of Computer Science**, Mägdelsprung, German Democratic Republic. (Nov. 1989, p. 1249)

15-21. **Mathematical Concepts of Dependable Systems**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

*16-20. **Using Algebraic Processors in Dynamical Systems**, University of Minnesota, Minneapolis, MN.

INVITED SPEAKERS: R. Grossman, J. Guckenheimer, D. Lewis, N. Lloyd, K. Meyer, P. Olver, D. Schmidt, B. Sturmfels.

INFORMATION: Institute for Mathematics and its Applications, 514 Vincent Hall, 206 Church St. S.E., Minneapolis, MN 55455; 612-624-4066.

17-21. **Phenomenes de Stokes et Resurgence**, Marseille, France. (Jan. 1990, p. 54)

*17-21. **International Conference on Effective Methods in Algebraic Geometry**, Castiglioncello (near Pisa), Italy.

CONFERENCE TOPICS: Effective methods and complexity issues in commutative algebra, projective geometry, real geometry, algebraic number theory; Algebraic geometric methods in

algebraic computing.

INVITED SPEAKERS: R. Benedetti, B. Buchberger, M. Demazure, G. Pfister, N. Vorobjov.

PROGRAM COMMITTEE: A. Conte (Torino), J. Davenport (Bath), A. Galigo (Nice), Y. Grigoriev (Leningrad), J. Heintz (Buenos Aires), W. Lassner (Leipzig), D. Lazard (Paris), H.M. Möller (Hagen), T. Mora (Genova), M. Pohst (Düsseldorf), T. Recio (Santander), J.J. Risler (Paris), M.F. Roy (Rennes), R. Schoof (Utrecht), C. Traverso (Pisa).

INFORMATION: C. Traverso, Dipartimento di Matematica, Via Buonarroti 2, I-56100 Pisa (Italy); email: traverso@icnucevm.bitnet.

- * 18-20. **Biological Fluid Dynamics Workshop**, Pittsburgh Supercomputing Center, Pittsburgh, PA.

PROGRAM: The workshop will familiarize biomedical researchers with computational methods for problems in biological fluid dynamics and provide practice in applying supercomputing resources to such problems. Previous supercomputing experience is not necessary. The workshop will emphasize computer modeling of flow problems in which a fluid interacts with an elastic or muscular boundary. The workshop is funded by a grant from the Division of Research Resources Biomedical Research Technology (BRT) Program of the National Institutes of Health (NIH).

DEADLINES: Deadline for submission of applications is March 15, 1990. Enrollment is limited to 20 participants. INFORMATION: C. Brooks, Biomedical Initiative Coordinator, Pittsburgh Supercomputing Center, 4400 Fifth Avenue, Pittsburgh, PA 15213, 412-268-5206 or 1-800-222-9310 (PA); 1-800-221-1641 (outside PA).

- 18-21. **Sixty-eighth Annual Meeting of the National Council of Teachers of Mathematics**, Salt Lake City, UT. (Jul./Aug. 1989, p. 766)

- 19-21. **Fourth National Conference on Undergraduate Research**, Union College, Schenectady, NY. (Nov. 1989, p. 1249)

- 19-21. **Conference on Function Spaces**, Southern Illinois University, Edwardsville, IL. (Dec. 1989, p. 1435)

- 19-22. **1990 Far Western Section, Uni-**

versity of New Mexico, Albuquerque, New Mexico.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

- 22-25. **Directions for the Decade in SUPERcomputing**, University of Florida, Gainesville, FL. (Jan. 1990, p. 54)

- 22-27. **Tenth Conference on Analytic Functions**, Kozubnik, Poland. (Oct. 1989, p. 1095)

- 22-28. **Einhollende Algebren und Ringe Von Differentialoperatoren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- * 24-26. **Second IMACS/ACM-SIGNUM International Conference on Expert Systems for Numerical Computing**, Purdue University, West Lafayette, Indiana.

ORGANIZING COMMITTEE: E. Houstis, J.R. Rice, R. Vichnevetsky.

INFORMATION: E. Houstis, Dept. of Comp. Sci., Purdue Univ., West Lafayette, IN 47907; 317-494-6003; Arpanet: enh@cs.purdue.edu.

- * 27-30. **Conference on Geometry and Topology**, Harvard University, Cambridge, MA.

SPONSOR: Lehigh University.

INVITED SPEAKERS: I. Singer, J. Kollar, R. Schoen, E. Witten.

- 28-29. **Symposium on Value Distribution Theory in Several Complex Variables**, Univ. of Notre Dame, Notre Dame, Indiana. (Nov. 1989, p. 1250)

- 29-May 5. **Gruppentheorie (Pro-Endliche Gruppen)**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- 30-May 4. **Mathematiques pour la Robotique**, Marseille, France. (Jan. 1990, p. 54)

May 1990

- 3-4. **Twenty-first Annual Pittsburgh Conference on Modeling and Simulation**, University of Pittsburgh, Pittsburgh, PA. (Sep. 1989, p. 916)

- 5-6. **Pacific Northwest Geometry Seminar**, University of Oregon, Eugene, OR. (Jan. 1990, p. 55)

- * 6-9. **Computer Algebra and Differential Equations (CADE-90)**, Cornell University, Ithaca, NY. (Please note changes from Dec. 1989, p. 1435)

INFORMATION: M. Singer, N.C. State

Univ., Dept. of Math., Box 2611, Raleigh, NC 27695-8205; 919-2671; singer%matag@ncsumath.ncsu.edu; singer@ncsumath.bitnet.

- 6-12. **Geschichte der Mathematik**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- 7-9. **1990 IEEE Symposium on Research in Security and Privacy**, Oakland, CA. (Oct. 1989, p. 1095)

- 7-10. **SIAM Conference on Applications of Dynamical Systems**, Orlando, FL. (1989, p. 916)

- 7-11. **Recent Advances in Regression**, Montréal, Canada. (Jan. 1990, p. 55)

- 7-11. **Algorithmes et Programmation**, Marseille, France. (Jan. 1990, p. 55)

- * 7-11. **Statistics Week**, Université de Montréal, Canada.

SPONSOR: Canadian Statistical Society.

ORGANIZING COMMITTEE: M. Bédard, G. Ducharme, C. Léger, Lepage, S. Tardif, Y. Yatracos (Coordinator).

INVITED SPEAKERS: L. Brown (Cornell U.), R. Carroll (Texas A&M U.), R.D. Cook (U. of Minnesota), K. Li (U.C.L.A.), C.E. Särndal (U. of Montréal), S. Weisberg (U. of Minnesota).

INFORMATION: S. Chênevert, J. Bédard, CRM, Université de Montréal, 6128-A, Montréal, QC, H3C 3J7, Canada; 514-343-7501; Fax: 514-343-2254; email: crm@cc.umontreal.ca

- 7-June 1. **College on Recent Developments and Applications in Mathematics and Computer Science**, International Centre for Theoretical Physics, Trieste. (May/Jun. 1989, p. 601)

- * 9-12. **Computer Algebra and Parallelism (CAP-90)**, Cornell University, Ithaca. (Please note changes from Dec. 1989, p. 1435)

INVITED SPEAKERS: J. von zur Gathen, B. Halstead, M. Karpinski, D. Kozen, G.L. Miller, W. Neun, B.S. Shostak, E. Sibert.

- 13-19. **Abstrakte Konvexe Analysis**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- 14-15. **Regional Workshop on Natural Conservation Laws**, Stony Brook. (Jan. 1990, p. 55)

- 14-18. **Conference on Nonlinear Analysis and Partial Differential Equations**, Rutgers University, New Brunswick, NJ. (Jul./Aug. 1989, p. 767)
- 14-18. **Workshop on K-Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 55)
- 14-18. **Singularities et Theorie de Hodge**, Marseille, France. (Jan. 1990, p. 55)
- 17-19. **Interface '90 (formerly Computer Science and Statistics: Symposium on Interface)**, East Lansing, MI. (Sep. 1989, p. 916)
- 17-19. **Colloquium: Computer Graphics in Pure Mathematics**, University of Iowa, Iowa City, IA. (Dec. 1989, p. 1435)
- 18-20. **Nineteenth Annual State of Jefferson Mathematics Congress**, Whiskeytown, CA.

INFORMATION: J. Ladwig, Dept. of Math. and Stat., California State Univ., Chico, CA 95929-0525.

- 20-25. **NSF/CBMS Conference on Operator Algebras**, Texas Christian University, Fort Worth, TX. (Jan. 1990, p. 55)
- 20-26. **The Schrödinger Equation and Its Classical Counterparts**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)
- 21-24. **The Simulation of Random Processes and Fields - Mathematics and Applications**, Portofino, Italy. (Sep. 1989, p. 916)
- 21-25. **NSF-CBMS Regional Conference on The Interface between Analytic Number Theory and Harmonic Analysis**, Manhattan, KS. (Jan. 1990, p. 55)
- 21-25. **Eleventh United States National Congress of Applied Mechanics**, Tucson, AZ. (Nov. 1988, p. 1389)
- 21-25. **Nonlinear Analysis, Function Spaces and Applications IV**, Czechoslovakia. (Jan. 1990, p. 56)
- 23-25. **1990 International Symposium on Multiple-Valued Logic**, Charlotte, NC. (Apr. 1989, p. 496)
- 23-25. **Workshop on Viscous and Numerical Approximation of Shock Waves**, North Carolina State University, Raleigh, NC.
- SPONSORS: Center for Research in Scientific Computation, NCSU; U.S. Army Research Office.
- CONFERENCE TOPICS: Travelling waves for viscous conservation laws, reaction diffusion equations, and numerical

cal methods for nonlinear hyperbolic equations.

INVITED SPEAKERS: M. Brio, R. Gardner, J. Glimm, D. Hoff, C. Jones, B. Keyfitz, T.-P. Liu, B. McKinney, R. Menikoff, K. Mischaikow, S. Osher, F. Palmeira, S. Schecter, M. Slemrod, J. Smoller, T. Ting, J. Trangenstein, Z.P. Xin.

CALL FOR PAPERS: There will be sessions for fifteen minute contributed papers. The title and abstract of papers should be received by March 20, 1990. A proceedings volume will be published.

INFORMATION: M. Shearer, Dept. of Math., North Carolina State University, Box 8205, Raleigh, NC 27695-8205; 919-737-3298; shearer@matagh.ncsu.edu.

- * 23-27. **Azumaya Algebras, Group Actions, and Modules: A Conference in Honor of Goro Azumaya's 70th Birthday**, Indiana University, Bloomington, IN.

PURPOSE: The dual purpose of this conference is to honor Goro Azumaya and to bring together for useful interaction mathematicians in three areas of Professor Azumaya's research: Azumaya algebras, group actions and module theory. These are areas of active research with significant historical intersection; the scientific aim of the conference is to encourage and revitalize that intersection.

ORGANIZERS: D. Haile, Indiana University and J. Osterburg, University of Cincinnati.

INVITED SPEAKERS: S. Amitsur, M. Artin, G. Azumaya, K. Fuller, S. Montgomery, D. Passman, D. Saltman, L. Small, and R. Swan.

INFORMATION: D. Haile, Dept. of Math., Indiana Univ., Bloomington, IN 47405; 812-855-2197; email: haile@iubacs.bitnet.

- * 24. **Second Conference on Lagrange Calculus**, Community College of Philadelphia, Philadelphia, PA.

PURPOSE: The conference is designed to bring together faculties engaged or interested in experimenting with a calculus based on Lagrange's approach, that is on the use of Taylor expansions obtained a priori and from which all the concepts of the calculus, including (sided) limits, are then derived.

PROGRAM: The conference will include a minicourse, contributed papers from faculties who have used the approach and a discussion session.

INFORMATION: A. Schremmer, Mathematics Department, Community College of Philadelphia, Philadelphia, PA 19130. Background papers will be sent on request.

- 24-25. **Twelfth Symposium on Mathematical Programming with Data Perturbations**, George Washington Univ., Washington, DC. (Nov. 1989, p. 1250)

24-26. **Conference on Probability Models in Mathematical Physics**, Colorado Springs, CO. (Jan. 1990, p. 56)

25-31. **Tenth International Conference on Pattern Recognition**, Resorts Hotel, Atlantic City, NJ. (Mar. 1988, p. 466)

27-June 2. **Lyapunov-Exponents**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

28-June 1. **Twenty-second Annual Conference on Statistics**, Tours, France. (Jan. 1990, p. 56)

28-June 1. **Tenth International Conference on Distributed Computing Systems**, Paris, France. (Jan. 1990, p. 56)

28-June 1. **Mecanique Celeste et Systemes Hamiltoniens**, Marseille, France. (Jan. 1990, p. 56)

- * 28-June 1. **Workshop on Set Theoretic Methods in Algebra**, Baylor University, Waco, Texas.

CONFERENCE THEME: The focus of the conference will be on the application of set theory in algebra, especially in abelian groups, rings and modules.

INVITED SPEAKERS: P. Eklof, A. Mekler.

INFORMATION: M. Dugas, Dept. of Math., Baylor Univ., Waco, TX 76798-7328; 817-755-3561; email: dugasm@baylor.bitnet.

- 28-June 2. **Geometry of Complex Projective Varieties**, Cetraro, Italy. (Nov. 1989, p. 1250)

29-30. **Algebraic Logic Conference in Honour of Professor Don Monk**, Boulder, Colorado. (Nov. 1989, p. 1250)

29-31. **GAMM/IFIP Workshop: "Stochastic Optimization: Numerical Methods and Technical Applications"**, Neubiberg, Federal Republic of Germany. (Jan. 1990, p. 56)

29-June 1. **Eleventh Annual Conference**

of the Canadian Applied Mathematics Society, Halifax, Nova Scotia. (Oct. 1989, p. 1096)

29-June 2. **Dynamical Theories of Turbulence in Fluid Flows**, Minneapolis, MN. (Nov. 1989, p. 1250)

29-June 2. **Workshop on Dynamical Systems in Fluid Mechanics**, Minneapolis, MN. (Nov. 1989, p. 1251)

30-31. **Conference on Algebraic Logic**, Boulder, Colorado. (Dec. 1989, p. 1436)

* 31-June 1. **Annual Meeting of the Canadian Society for History and Philosophy of Mathematics**, University of Victoria, British Columbia.

PURPOSE: The aim of the conference is to exchange ideas in the history and philosophy of mathematics. There will be a special session on history and pedagogy of mathematics organized by Victor Katz, Univ. of the District of Columbia, Washington, DC in which J. Grabiner is the principle speaker.

INFORMATION: F. Abeles, Dept. of Math./Comp. Sci., Kean College, SCNJ, Union, NJ 07083; cpsf01@turbo.kean.edu.

31-June 3. **Percolation Models of Material Failure**, Cornell University, Ithaca, NY. (Dec. 1989, p. 1436)

June 1990

June/July 1990. **International IMACS Conference on Mathematical Modelling and Applied Mathematics**, Vilnius, USSR. (Sep. 1989, p. 917)

1-8. **Third International Symposium on Orthogonal Polynomials and Their Applications**, Erice-Trapani (Sicily), Italy. (Dec. 1989, p. 1436)

1-10. **Fourth Annual Meeting of the International Workshop in Analysis and its Applications**, Dubrovnik-Kupari, Yugoslavia. (Oct. 1989, p. 1096)

3-6. **1990 Annual Meeting of the Statistical Society of Canada**, St. John's, Newfoundland, Canada. (Sep. 1989, p. 917)

3-6. **Symposium on Chaos in Biological and Agricultural Systems**, Lincoln, Nebraska. (Jan. 1990, p. 56)

3-9. **Graphentheorie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

4-7. **Fifth Annual IEEE Symposium on Logic in Computer Science**, Philadelphia, PA. (Sep. 1989, p. 917)

4-8. **Workshop on Model Theory**, Berkeley, CA. (Sep. 1989, p. 917)

4-8. **Nonlinear Phenomena in Atmospheric and Oceanic Sciences**, Minneapolis, MN. (Nov. 1989, p. 1251)

4-8. **International Conference on Approximation Interpolation and Summability in Honor of A. Jakimovski**, Tel Aviv, Israel. (Dec. 1989, p. 1436)

4-8. **International Conference on Bootstrapping and Related Techniques**, Trier, Federal Republic of Germany. (Jan. 1990, p. 56)

* 4-12. **Recent Developments in Geometric Topology and Related Topics**, Villa "La Querceta", Montecatini Terme.

SCIENTIFIC DIRECTORS: P. De Bartolomeis (Univ. di Firenze), E. Tricceri (Univ. di Firenze).

INVITED SPEAKERS: Ch. Okonek (Univ. Bonn, BRD), J. Cheeger (Courant Inst., USA), M. Gromov (I.H.E.S., France).

INFORMATION: P. Zecca, Secretary, CIME, Istituto Matematico U. Dini, Viale Morgagni, 67/A, I 50134 Firenze, Italy.

4-15. **Analyse Harmonique sur Les Groupes Reductifs P-Adiques**, Marseille, France. (Jan. 1990, p. 56)

* 4-28. **Supercomputing Program for Undergraduate Research**, Cornell National Supercomputing Facility, Ithaca, NY.

INFORMATION: D. Smith, Conference Coordinator, CNSF, Campus Rd. and Central Ave., Ithaca, NY 14853-8301; 607-255-3985; 1-800-346-2673; donna@tcgould.tn.cornell.edu. Applications must be received by March 23, 1990. A stipend of \$2,000 for the four-week course will be provided to undergraduates who are accepted.

6-8. **First IFIP Conference on Fractals**, Lisbon, Portugal. (Jan. 1990, p. 57)

6-9. **Fifth Annual Conference of the European Consortium for Mathematics in Industry**, Lahti, Finland. (Apr. 1989, p. 496)

6-12. **1990 Barcelona Conference on Algebraic Topology**, Centre de Recerca Matematica, Barcelona, Spain. (Sept. 1988, p. 1060)

6-15. **Third Logical Biennial (in honor of S.C. Kleene)**, Chaika (near Varna), Bulgaria. (Oct. 1989, p. 1096)

7-July 4. **1990 Joint Summer Research Conferences in the Mathematical Sciences**, University of Massachusetts Amherst, MA.

INFORMATION: C. Kohanski, Amherst, MA
P.O. Box 6248, Providence, RI 02902

* 10-14. **Sixth Haifa Matrix Conference**, Technion City, Haifa, Israel.

ORGANIZING COMMITTEE: A. Ben-Israel and D. Hershkowitz.

INFORMATION: Dept. of Math., Technion-Israel Institute of Technology, Haifa 32000, Israel; emar23aa@technion.bitnet
emar64aa@technion.bitnet.

10-16. **Reelle Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

10-16. **Fourth Czechoslovak Symposium on Combinatorics**, Prachtice, Czechoslovakia. (Nov. 1989, p. 1251)

11-14. **Fourteenth Rolf Nevanlinna Colloquium**, University of Helsinki, Helsinki, Finland. (Jul./Aug. 1989, p. 767)

11-14. **World Organization of Systems and Cybernetics Eighth International Congress**, New York, NY. (Mar. 1989, p. 917)

11-14. **Fifth SIAM Conference on Discrete Mathematics**, Atlanta, GA. (Jan. 1989, p. 917)

11-15. **Chaotic Processes in the Geographical Sciences**, Minneapolis, MN. (Nov. 1989, p. 1251)

11-15. **Third International Conference on Hyperbolic Problems**, Uppsala, Sweden. (Jan. 1990, p. 57)

11-15. **Rigorous Results in Quantum Dynamics**, Liblice Castle, Czechoslovakia. (May/Jun. 1989, p. 602)

11-15. **NSF/CBMS Conference on Wavelets**, University of Lowell, Lowell, MA. (Nov. 1989, p. 1251)

11-15. **IMACS First International Conference on Computational Physics**, Boulder, CO. (Jan. 1990, p. 57)

12-15. **Ninth International Conference on Analysis and Optimization of Systems**, Antibes, France. (Jan. 1990, p. 57)

* 12-15. **Workshop on Spectral and Filtering Theory of Partial Differential Equations**, Institute of Mathematics, Hebrew Univ., Jerusalem, Israel.

PROGRAM: Invited Talks.

SPONSOR: U.S.-Israel Binational Science Foundation.

ORGANIZERS: M. Ben-Artzi, P. Constantin, Y. Kannai, Y. Kifer, M. Marcus, E. Shamir.

INFORMATION: Secretary, Conference on PDE, Institute of Mathematics, Hebrew Univ., Jerusalem 91904, Israel.

13-15. **Seventh Annual Quality and Productivity Research Conference**, Madison, WI. (Mar. 1989, p. 315)

*13-16. **Function Estimation and Statistical Applications**, Cornell University, Ithaca, NY.

ORGANIZERS: D. Ruppert, Cornell Univ.; J.S. Marron, Univ. of North Carolina, Chapel Hill.

PURPOSE: This workshop is on modern statistical methods that do not rely on parametric assumptions.

INVITED SPEAKERS: N. Altman, R.J. Carroll, D. Cline, D. Cox, R. Eubank, P. Hall, I. Johnstone, R. Liu, J.S. Marron, D. Nychka, J. Rice, D. Scott, P. Speckman, M. Wells.

INFORMATION: D. Ruppert, School of Operations Research and Industrial Engineering, Cornell Univ., 343A Upson Hall, Ithaca, NY 14853; 607-255-9136; davidr@orie.cornell.edu.

13-22. **Free Boundary Problems: Theory and Applications**, Centre de Recherches Mathématiques, Université de Montréal, Canada. (Jul./Aug. 1989, p. 767)

*14-16. **Sixth Summer Conference on General Topology and Applications**, Long Island Univ. (C.W. Post Campus), Brookville, NY.

ORGANIZING COMMITTEE: S. Andima (Chair), Long Island Univ.; E. Beckenstein, St. John's SI; N. Cleopa, Long Island Univ.; S. Hechler, Queens College-CUNY; M. Henriksen, Harvey Mudd College; R. Kopperman, City College of NY-CUNY; P. Misra, College of Staten Island-CUNY; C. Neville, Central Conn. State College; R. Resch, College of Staten Island-CUNY; R. Shortt, Wesleyan; A. Todd, Baruch College; J. Vaughan, Univ. of North Carolina at Greensboro.

CONFERENCE TOPICS: General topology, relations between general topology and functional analysis, category theory, computer science, and other

fields.

INVITED SPEAKERS: A.V. Arhangel'skii (Moscow State Univ.), B. Banaschewski (McMaster Univ.), W.W. Comfort (Wesleyan Univ.), G. Gruenhage (Auburn Univ.), L. Nachbin (Brazilian Center for Physical Research; Univ. of Rochester), S. Watson (York Univ.).

CALL FOR PAPERS: Participants are invited to present half-hour talks. Abstracts should be submitted by May 1, 1990.

INFORMATION: S. Andima, Department of Mathematics, Long Island Univ., C.W. Post Campus, Brookville, NY 11548; 516-299-2448; email: andima@liuvax.bitnet.

14-16. **Fifth Southeast Asian Conference on Mathematical Education (SEACME 5)**, Gadong, Brunei Darussalam. (Nov. 1989, p. 1251)

15-20. **Global Differential Geometry and Global Analysis**, Berlin, Federal Republic of Germany. (Jan. 1990, p. 57)

17-23. **Partial Differential Equations in Complex Analysis**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

18-20. **Joint WNAR-IMS Regional Meeting**, Montana State University, Bozeman, MT. (Mar. 1989, p. 315)

*18-21. **A Conference on Partial Differential Equations, in Honor of Shmuel Agmon**, Institute of Mathematics, Hebrew Univ., Jerusalem, Israel.

PROGRAM: Invited Talks.

SPONSORS: Israel Academy of Sciences, Hebrew Univ., Technion-Israel Institute of Technology.

ORGANIZERS: M. Ben-Artzi, P. Constantin, Y. Kannai, Y. Kifer, M. Marcus, E. Shamir.

INFORMATION: Secretary, Conference on PDE, Institute of Mathematics, Hebrew Univ., Jerusalem 91904, Israel.

18-22. **Fourteenth Mathematical Sciences Lecture Series on Partially Ordered Sets**, Johns Hopkins University, Baltimore, Maryland. (Oct. 1989, p. 1096)

18-22. **Approximations Diophantiennes et Nombres Transcendants**, Marseille, France. (Jan. 1990, p. 57)

*18-26. **Recent Developments in H_∞ Control Theory**, Villa Olmo, Como.

SCIENTIFIC DIRECTORS: E. Mosca (Univ. di Firenze), L. Pandolfi (Pol. di Torino).

INVITED SPEAKERS: F. Foias (Indiana Univ.), H. Kwakernaak (Univ. of Twente, The Netherlands), J.P. Pearson (Rice Univ.), B.A. Francis (Univ. of Toronto), I.W. Helton (Univ. of California at San Diego).

INFORMATION: P. Zecca, Secretary, CIME, Istituto Matematico U. Dini, Viale Morgagni, 67/A, I 50134 Firenze, Italy.

18-29. **Radar/Sonar**, Minneapolis, MN. (Nov. 1989, p. 1251)

18-29. **AMS-SIAM Summer Seminar on Vortex Dynamics and Vortex Methods**, University of Washington, Seattle, WA.

INFORMATION: B. Verducci, AMS, P.O. Box 6248, Providence, RI 02940.

20-22. **Sixteenth International Workshop on Graph-Theoretic Concepts in Computer Science**, Berlin, Federal Republic of Germany. (Jan. 1990, p. 57)

24-30. **Mathematische Probleme in der Nichtlinearen Elastizität**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

25-29. **International Symposium on Fuzzy Approach to Reasoning and Decision Making**, Bochyne, Czechoslovakia. (Oct. 1989, p. 1096)

*25-29. **Logique et Informatique**, Marseille, France. (Please note changes from Jan. 1990, p. 58)

PURPOSE: The purpose of the meeting is to bring together logicians and computer scientists. Most of the talks will be invited lectures so there should be ample time for discussions.

CONFERENCE TOPICS: Categorical logic, complexity theory, logic programming, modal logic, type theory.

PROGRAM COMMITTEE: S. Artemov (Moscow), G. Blanc (Marseille), L. Esakia (Tbilisi), A. Preller (Montpellier).

ORGANIZER: G. Blanc.

INVITED SPEAKERS: M. Abashidze (Tbilisi), K. Apt (Amsterdam), J. Barzdin (Riga), L. Beklemishev (Moscow), A. Berarducci (Siena), C. Bernardi (Roma), Cl. Bertrand (Marseille), A. Blass (Ann Arbor), G. Boole (MIT), E. Borgër (Pisa), A. Chan-

dra (IBM-New York), Th. Coquand (INRIA-Paris), G. Corsi (Firenze), D. de Jongh (Amsterdam), Ph. Enjalbert (Caen), L. Farinas (Toulouse), M. Fitting (New York), M. Fouda (Montpellier), J.Y. Girard (Paris), Y. Gurevitch (Ann Arbor), G. Japaridze (Tbilisi), J.L. Krivine (Paris), J.L. Lassez (IBM-NY), G. Mints (Tallin), F. Montagna (Siena), H. Ono (Hiroshima), J. Paris (Manchester), A.M. Pitts (Cambridge), V. Sazonov (Novosibirsk), E. Shapiro (Weizmann Inst.), V. Shevrukov (Moscow), C. Smorynski (San Jose), R. Smullyan (New York), R. Solovay (Berkeley), Th. Streicher (Pasau), J. Stern (Paris), A. Visser (Utrecht).

25-July 13. **SMS-NATO ASI: Shape Optimization and Free Boundaries**, Université de Montréal, Montréal, Canada. (Dec. 1989, p. 1437)

27-29. **ACM Conference on Lisp and Functional Programming**, Nice, France. (Jan. 1990, p. 58)

27-30. **Fourth International Congress on Algebraic Hyperstructures and Applications**, Xanthi, Greece. (Apr. 1989, p. 496)

July 1990

July 1990. **AMS Summer Research Institute on Differential Geometry**, University of California, Los Angeles, CA.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

1-7. **Modulfunktionen In Mehreren Variablen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

1-15. **International Symposium on Algebraic Topology - Adams Memorial Symposium**, University of Manchester, England. (Sep. 1989, p. 918)

1-18. **Twentieth Summer Session on Probability Theory**, Saint-Flour (Cantal), France. (Mar. 1989, p. 315)

2-6. **Tenth Australian Statistical Conference/Second Pacific Statistical Congress**, Sydney, Australia. (Jul./Aug. 1989, p. 768)

2-6. **The Jónsson Symposium**, Laugarvatn, Iceland. (Sep. 1989, p. 918)

2-6. **Thirty-fourth Annual Meeting of the Australian Mathematical Society**, Townsville, Queensland, Australia. (Oct. 1989, p. 1097)

ville, Queensland, Australia. (Oct. 1989, p. 1097)

2-6. **Fifteenth International Biometric Conference**, Budapest, Hungary. (Jan. 1990, p. 58)

2-7. **Groupes Ordonnés et Groupes de Permutation**, Marseille, France. (Jan. 1990, p. 58)

*2-10. **Continua with Microstructures**, Villa "La Querceta", Montecatini Terme.

SCIENTIFIC DIRECTOR: G. Capriz (Univ. di Pisa).

INVITED SPEAKERS: C. Davini (Univ. di Udine), N.D. Mermin (Cornell Univ.), J.T. Jenkins (Cornell Univ.), M. Kléman (Univ. Paris-Sud, France).

INFORMATION: P. Zecca, Secretary, CIME, Istituto Matematico, U. Dini, Viale Morgagni, 67/A, I 50134 Firenze, Italy.

2-31. **Time Series**, Minneapolis, MN. (Nov. 1989, p. 1252)

*2-August 10. **Représentations des Groupes et des Algèbres de Lie**, Université de Montréal, Canada.

ORGANIZER: R. Langlands (IAS, CRM).
INVITED SPEAKERS: J. Arthur (Univ. of Toronto), L. Clozel (Univ. de Paris, Orsay), R. Langlands (IAS, CRM), R. Moody (Univ. of Alberta), L. Vinet (Univ. de Montréal).

INFORMATION: S. Chênevert, J. Roy, CRM, Université de Montréal, C.P. 6128-A, Montréal, Québec, H3C 3J7 Canada; 514-343-7501; Fax: 514-343-2254; email: crm@cc.umontreal.ca.

3-6. **Eleventh Dundee Conference on Ordinary and Partial Differential Equations**, Dundee, Scotland. (Sep. 1989, p. 918)

*5-7. **Lattice Path Combinatorics and Applications**, McMaster University, Hamilton, Ontario, Canada.

INFORMATION: S.G. Mohanty, McMaster Univ., Dept. of Math. and Stat., Hamilton, Ontario, Canada; 416-525-9140, ext. 3422; email: mohanty@ssc.vax.mcmaster.ca.

*6-7. **International Colloquium on Applications of Mathematics (on the occasion of the 80th birthday of Lothar Collatz)**, Hamburg, West Germany. (Please note changes from Nov. 1989, p. 1252)

INFORMATION: G. Opfer, University of Hamburg, Institute of Applied

Mathematics, Bundesstraße 55, 2000 Hamburg 13, West Germany.

8-14. **Variationsrechnung**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

9-11. **"Universita'di Genova - The Old State University Joint Conference" New Trends in Systems Theory**, Genova, Italy. (Jul./Aug. 1989, p. 768)

9-14. **4eme Colloque International Theorie des Graphes et de Combinatoire**, Marseille-Luminy, C.I.R.M., France. (May/June 1990, p. 58)

9-20. **Geometry and Topology of Free Manifolds**, McMaster University, Hamilton, Ontario, Canada. (May/Jun. 1990, p. 602)

15-21. **Stochastic Image Models and Algorithms**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

*15-22. **1990 European Summer Meeting (Logic Colloquium '90)**, University of Helsinki, Finland. (Please note change from Nov. 1989, p. 1252)

PURPOSE: Logic Colloquium '90 is the annual European Summer Meeting of the Association for Symbolic Logic.
ORGANIZERS: J. Väänänen (Chairman), I. Niiniluoto (Vice Chairman).
CONFERENCE TOPICS: Model Theory, Set theory, proof theory, computational science and recursion theory, and philosophy.

INVITED SPEAKERS: D. Gabbay, Jensen, P. Kolaitis, R. Laver, P. M. Löf, A. Mekler, G. Mints, Moschovakis, S. Shelah.

CALL FOR PAPERS: Contributed papers for 20 minute talks are invited from all areas of logic. Abstracts of one typewritten page (maximum words) should be sent before April 1990.

15-23. **Colloquium in Honor of Robert Fraisse**, Centre International de Recherches Mathématiques, Luminy, France. (May/Jun. 1989, p. 602)

16-20. **SIAM Annual Meeting**, Chicago, IL. (Nov. 1988, p. 1389)

16-20. **Symposium Fraisse**, Marseille, France. (Jan. 1990, p. 58)

22-28. **Konvexgeometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

*23-27. **CADE 10 - Tenth International Conference on Automated**

tion, West Germany.

CONFERENCE TOPICS: Theorem proving, unification, term rewriting, decision procedures, program verification/synthesis, deductive databases, logic programming, inference systems, applications.

PROGRAM COMMITTEE: P. Andrews, W. Bibel, W.W. Bledsoe, A. Bundy, R. Constable, J.-P. Jouannaud, D. Kapur, M. Kaufmann, C. Kirchner, J.-L. Lassez, D. Loveland, E. Lusk, M. McRobbie, D. Miller, H.J. Ohlback, R. Overbeek, W. Pase, L. Paulson, F. Pereira, D. Plaisted, J. Siekmann, M. Stickel (Chair), R. Waldinger, C. Walther.

INFORMATION: M. Stickel, Artificial Intelligence Center, SRI International, 333 Ravenswood Ave., Menlo Park, CA 94205.

23-28. **Fourth International Congress on Computational and Applied Mathematics**, Leuven, Belgium. (Jan. 1990, p. 58)

23-August 4. **Third Workshop on Stochastic Analysis**, Silivri, Istanbul-Turkey.

PROGRAM: The first week will be devoted to lectures and the second week to contributed talks. All participants are encouraged to give a talk. The deadline for the titles with a brief summary is May 1, 1990.

INFORMATION: H. Korezlioglu (1-45817495) or A.S. Ustunel (1-45817267), E.N.S.T., Dépt. Réseaux, 46, Rue Barrault, 75634 Paris cedex 13, France; Fax: 1-45891664, email: korez@ulyse.enst.fr.

26-29. **International Conference on New Trends in Geometric Function Theory and Applications**, University of Madras, Madras, India. (Sep. 1989, p. 918)

29-August 4. **Mechanik Und Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

30-August 4. **The Fourth International Conference on Fibonacci Numbers and their Applications**, Wake Forest University, Winston Salem, NC. (Nov. 1989, p. 1252)

31-August 2. **Dynamics of Numerics and the Numerics of Dynamics**, Bristol, England. (Nov. 1989, p. 1252)

August 1990

5-9. **From Topology to Computation: Unity and Diversity in the Mathematical Sciences (in Honor of Professor Stephen Smale's 60th Birthday)**, Berkeley, CA. (Jan. 1990, p. 58)

5-11. **Mathematical Methods in Tomography**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

5-11. **International Conference on Approximation Theory**, Hungary. (Oct. 1989, p. 1097)

6-7. **AMS Short Course on Combinatorial Games**, Columbus, Ohio.

INFORMATION: M. Foulkes, AMS, P.O. Box 6248, Providence, RI 02940.

6-9. **1990 Joint Statistical Meetings**, Anaheim, CA. (Mar. 1988, p. 466)

* 6-10. **Singularities**, Honolulu, Hawaii.

PROGRAM: The conference will cover all branches of singularity theory, but with emphasis on singularities of mappings, singularities of real varieties, foundational properties (differential analysis, subanalytic sets, etc.), and applications (e.g. to differential geometry). Speakers will be determined near to the time of the conference.

ORGANIZERS: L.C. Wilson (Univ. of Hawaii), W. Kucharz (Univ. of Hawaii), T. Gaffney, (Northeastern Univ.), A. du Plessis (Aarhus Univ.).

INFORMATION: L.C. Wilson, Dept. of Math., Univ. of Hawaii at Manoa, Honolulu, HI 96822; 808-948-7217; email: les@uhccux.uhcc.hawaii.edu or les@uhccux.bitnet.

8-11. **Joint Mathematics Meetings**, Ohio State University, Columbus, OH. (including the summer meetings of the AMS, AWM, MAA and PME). This is the 75th Anniversary of the MAA.

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

12-18. **Algebraische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

* 12-18. **Pre-Congress Topology Conference**, University of Hawaii, Honolulu, HI. (Please note change from Feb. 1989, p. 183)

INFORMATION: For a copy of the second announcement contact K.H. Dovermann at the Univ. of Hawaii.

13-16. **Alaska Conference, Quo Vadis, Graph Theory?**, University of Alaska, Fairbanks, AK. (Oct. 1989, p. 1097)

13-17. **Fifth International Conference on Hadronic Mechanics and Nonpotential Interactions**, University of Northern Iowa, Cedar Falls, Iowa. (Jul./Aug. 1989, p. 768)

13-17. **Eleventh IFAC World Congress**, Tallin, USSR. (Sep. 1989, p. 918)

13-17. **Algebraic Geometry and Analytic Geometry**, Tokyo, Japan. (Sep. 1989, p. 919)

13-17. **1990 International Conference on Parallel Processing**, Pennsylvania State University, University Park, PA. (Dec. 1989, p. 1438)

13-18. **Institute of Mathematical Statistics Fifty-third Annual Meeting (jointly with the Second World Congress of the Bernoulli Society)**, Uppsala, Sweden. (Sep. 1989, p. 919)

13-18. **Tsukuba International Conference on Representations of Algebras and Related Topics**, University of Tsukuba, Japan. (Nov. 1989, p. 1253)

14-18. **The Asian Mathematical Conference 1990**, Hong Kong, China. (Sep. 1989, p. 919)

* 14-18. **Harmonic Analysis, Sendai 1990**, Tohoku University, Sendai, Japan.

CONFERENCE TOPICS: Recent progress in the field of harmonic analysis with emphasis on Fourier analysis on Euclidean spaces. The related fields and their applications.

INFORMATION: S. Igari, Mathematical Institute, Tohoku Univ., Sendai 980, Japan; Phone: 022-222-1800 ext. 3210, 3234; Fax: 022-263-6793.

* 14-18. **Zeta Functions in Geometry**, Tokyo Institute of Technology, Tokyo, Japan.

CONFERENCE TOPICS: Various zeta functions and L-functions in spectral geometry, dynamical systems, algebraic geometry, and number theory, including the Riemann zeta function and Selberg zeta functions.

INFORMATION: T. Sunada, Dept. of Math., Faculty of Science, Nagoya Univ., Nagoya 464-01, Japan; Phone: 052-781-5111 ext. 6638; Fax: 052-

781-4437. Deadline for registration: May 31, 1990.

15-19. **International Conference on Knot Theory and Related Topics**, International House, Osaka, Japan. (Apr. 1989, p. 497)

* 15-19. **International Conference on Commutative Algebra and Combinatorics**, Nagoya University, Nagoya, Japan.

INFORMATION: H. Matsumura, Dept. of Math., Faculty of Science, Nagoya Univ., Nagoya 464-01, Japan; Phone: 052-781-5111 ext. 6434; Fax: 052-781-4437.

15-20. **Conference on Gaussian Random Fields (The Third Nagoya Lévy Seminar)**, Nagoya University, Nagoya, Japan. (Nov. 1989, p. 1253)

16-18. **SIGAL International Symposium on Algorithms**, Tokyo, Japan. (Oct. 1989, p. 1097)

* 16-19. **Current Topics in Operator Algebras**, Nara Ken-New Public Hall, Nara, Japan.

CONFERENCE TOPICS: C^* -dynamical systems and derivations, non commutative differential geometry, index theory, quantum groups and galois theory.

INFORMATION: Y. Nakagami, Dept. of Math., Yokohama City Univ., 22-2 Seto, Kanazawa-ku, Yokohama 236, Japan; Phone: 045-787-2198; Fax: 045-787-2202.

* 18-22. **The Second International Conference on Graph Theory**, Kanagawa, Japan.

INFORMATION: H. Akiyama, Dept. of Math., Tokai Univ., Hiratsuka, Kanagawa 259-12, Japan.

* 19-20. **Inverse Problems in Engineering Sciences**, Osaka Institute of Technology, Osaka, Japan.

CONFERENCE TOPICS: Inverse scattering problems, determination of unknown coefficients in differential equations, inverse eigenvalue problems, determination of boundaries and domains, parameter estimation, numerical analysis and synthesis for those problems.

DEADLINES: Deadline for registration: June 30, 1990; Deadline for submission of papers: April 30, 1990.

INFORMATION: M. Yamamoto, Dept. of Math., College of Arts and Sci-

ences, Univ. of Tokyo, Komaba, Meguro, Tokyo 153, Japan; Phone: 03-467-1171 ext. 443 or 296; Fax: 2426-728.

19-25. **Mathematische Methoden Des VLSI-Entwurfs Und Des Distributed Computings**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

* 20-24. **Second International joint Conference of the ISSAC-90 and the AAECC-8**, Nihon University, Tokyo, Japan.

CONFERENCE TOPICS: Symbolic and algebraic computation, error correcting codes, etc.

INFORMATION: H. Kobayashi, Conference Secretariat IJC-2, c/o Scientist, Inc., Yamazaki Bldg., 3-2 Kanda Surugadai, Chiyoda-ku, Tokyo, 101, Japan; Fax: 03-255-6847.

20-25. **Fifth Conference on Numerical Methods**, Miskolc, Hungary. (Jan. 1990, p. 59)

21-29. **The International Congress of Mathematicians 1990**, Kyoto, Japan. (Nov. 1988, p. 1389)

23-September 1. **Twenty-eighth International Symposium on Functional Equations**, Graz-Mariatrost, Austria. (Dec. 1989, p. 1438)

26-September 1. **Komplexe Analysis**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

27-31. **Eleventh Prague Conference on Information Theory, Statistical Decision Functions and Random Processes**, Praha, Czechoslovakia. (Jan. 1990, p. 59)

28-30. **IMACS European Simulation Meeting on Problem Solving by Simulation**, Esztergom, Hungary. (Mar. 1989, p. 316)

28-31. **Operations Research 1990, International Conference Operations Research**, Vienna, Austria. (Jul./Aug. 1989, p. 768)

* 29-31. **International Colloquium on Words, Languages, and Combinatorics**, Kyoto Sangyo University, Kyoto, Japan.

CONFERENCE TOPICS: Codes, free monoids, transformation semigroups, automata, formal languages, word problems and combinatorics.

INFORMATION: M. Ito, Dept. of Math., Faculty of Science, Kyoto Sangyo Univ., Kyoto 603, Japan; phone: 075-701-2151; Fax: 075-722-2630.

* 30-September 1. **International Sympo-**

sium on the Semigroup Theory and Related Fields, Ritsumeikan University, Kyoto, Japan.

CONFERENCE TOPICS: Semigroup theory and its related fields; theory automata, universal algebra and lattice theory.

INFORMATION: M. Yamada, Dept. Math., Shimane Univ., 1060 Nishiwatsu-cho, Matsue 690, Japan; phone: 0852-21-7100; Fax: 0852-31-0812

* 30-September 2. **International Symposium on Functional Differential Equations and Related Topics**, Kyoto Shiga Kaikan (YOUANDI), Kyoto, Japan.

INFORMATION: J. Kato, Mathematical Institute, Tohoku Univ., Sendai 980, Japan; phone: 022-222-1800; Fax: 022-262-6609.

30-September 4. **International Conference on Potential Theory**, Nagoya, Japan. (May/Jun. 1989, p. 602)

* 30-September 4. **International Symposium on Computational Mathematics**, Matsuyama, Japan.

INFORMATION: T. Yamamoto, Dept. of Math., Fac. of Sci., Ehime Univ., Matsuyama, Ehime 790, Japan.

* 31-September 1. **Tokyo History of Mathematics Symposium 1990**, University of Tokyo, Tokyo, Japan.

CONFERENCE TOPICS: History of modern mathematics, mathematical traditions in the east.

INFORMATION: C. Sasaki, Dept. History and Philosophy of Sci., College of Arts and Sciences, University of Tokyo, Komaba, Meguro-Ku, Tokyo 153, Japan; phone: 03-467-1171 ext. 363, 543; Fax: 03-467-2568.

* 31-September 2. **Conference on Representation Theories of Lie Groups and Algebras**, Lake-Kawaguchi, Yamaguchi, Japan.

CONFERENCE TOPICS: Representation theories of real and p-adic Lie groups and Lie algebra, harmonic analysis on homogeneous spaces, their applications and related topics.

INFORMATION: T. Oshima, Dept. Math., Fac. of Sci., Univ. of Tokyo, Tokyo 113, Japan; Fax: 03-814-

email: c31282%tansei.cc.u-tokyo.ac.jp
@relay.cs.net.

31-September 4. **International Symposium on Functional Analysis and Related Topics**, Sapporo, Japan.

CONFERENCE TOPICS: Banach spaces, banach algebras, function spaces, harmonic analysis, operator theory, applications of functional analysis and related topics.

INFORMATION: S. Koshi, Dept. of Math., Fac. of Sci., Hokkaido Univ., Sapporo 060, Japan; phone: 011-716-2111 ext. 2672; Fax: 011-727-3705; deadline for registration: May 31, 1990.

31-September 4. **General Topology and Geometric Topology Symposium**, University of Tsukuba, Japan.

CONFERENCE TOPICS: Topological spaces, set-theoretic topology, dimension theory, shape theory, ANR theory, and continua theory.

INFORMATION: Y. Kodama, Institute of Mathematics, Univ. of Tsukuba, Ibaraki 305, Japan; phone: 0298-53-4375; Fax: 0298-53-6501.

September 1990

September/October 1990. **IMACS-GAMM Conference on Computer Arithmetic, Scientific Computation and Mathematical Modelling**, Bulgaria. (Sep. 1989, p. 919)

IMACS Symposium on Modelling and Simulation of Electrical Machines, ENSEM - Nancy, France. (May/Jun. 1989, p. 602)

2-7. **Twelfth International Conference on Nonlinear Oscillations**, Cracow, Poland. (Sep. 1989, p. 919)

2-7. **International Conference on Integral Equations and Boundary Value Problems**, Yantai University, Shandong, People's Republic of China. (Nov. 1989, p. 1253)

2-8. **Topologie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

3-6. **Fourth Asian Logic Conference**, Tokyo, Japan. (Mar. 1989, p. 316)

3-7. **IMACS Symposium on Intelligent Models in Systems Simulation**, Brussels, Belgium. (Mar. 1989, p. 316)

3-7. **Representation des Groupes et Analyse Complexe**, Marseille, France. (Jul./Aug. 1989, p. 768)

* 3-7. **International Conference on Dynamical Systems and Related Topics**, Nagoya University, Nagoya, Japan.

INFORMATION: K. Shiraiwa, Dept. of Math., College of General Education, Nagoya Univ., Nagoya 464-01, Japan; phone: 052-781-5111 ext. 4749; Fax: 052-782-8261.

8-12. **Neuronet-90: IMACS International Symposium on Neural Nets and Neural Computers**, Prague, Czechoslovakia. (Please note change from May/Jun. 1989, p. 602)

9-15. **Surgery and L-Theory**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

10-12. **Second International Workshop on Advances in Robot Kinematics**, Linz, Australia. (Jan. 1990, p. 59)

10-14. **Mathematiker-Kongress**, Dresden, German Democratic Republic. (Jul./Aug. 1989, p. 769)

10-14. **Greco Calcul Formel**, Marseille, France. (Jan. 1990, p. 60)

10-October 5. **School on Qualitative Aspects and Applications of Nonlinear Evolution Equations**, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 602)

16-22. **Risikothorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

17-21. **Atelier International de Theorie des Ensembles**, Marseille, France. (Jan. 1990, p. 60)

17-22. **DMV-Jahrestagung 1990**, Bremen, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

23-29. **Random Graphs and Combinatorial Structures**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

24-28. **International Symposium on Mathematical Theories**, San Sebastián, Spain. (Jan. 1990, p. 60)

24-28. **Structure Galoisienne Arithmetique**, Marseille, France. (Jan. 1990, p. 60)

* 24-28. **IMACS-GAMM International Symposium on Computer Arithmetic, Scientific Computation and Mathematical Modelling - SCAN 1990**, Albena (near Varna), Bulgaria.

PURPOSE: The conference is devoted to some new trends in the field of scientific computation. It should serve as a forum for the presentation of new ideas in relation with this methodol-

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ogy and for the exchange of experiences in its use in various areas of scientific modelling situations.

CALL FOR PAPERS: Three copies of an extended abstract (max. of 4 pages) are to be submitted to the address below. Deadlines: submission of abstract-April 30, 1990; notification of acceptance-June 30, 1990; Registration-July 30, 1990.

INFORMATION: S. Markov, Coordinating Centre for Informatics and Computer Technology, Bulgarian Academy of Sciences, Acad. G. Bonichev str., bl.25a, BG-1113 Sofia, Bulgaria; Telex: 22628; Telefax: 359-2-707273.

* 24-29. **Mathematical Modelling of Industrial Processes**, TecnoPolis, Bari.

SCIENTIFIC DIRECTORS: V. Capasso (Univ. di Bari), A. Fasano (Univ. di Firenze).

INVITED SPEAKERS: B. Forte (Univ. of Waterloo), H.K. Kuiken (Philips Research Lab., Olanda), S. Busenberg (Harvey Mudd College).

INFORMATION: P. Zecca, Secretary, CIME, Istituto Matematico U. Dini, Viale Morgagni, 67/A, I 50134 Firenze, Italy.

30-October 6. **Diophantische Approximationen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

October 1990

1-5. **Organisations et Theorie des Jeux**, Marseille, France. (Jan. 1990, p. 60)

5-6. **Math-History Conference**, LaCrosse, WI. (Jan. 1990, p. 60)

7-13. **Arbeitsgemeinschaft Mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

8-12. **Congres Franco-Sovietique de Programmation Mathematique**, Marseille, France. (Jan. 1990, p. 60)

14-20. **Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

15-19. **Modeles pour L'Analyse des Donnees Multidimensionnelles**, Marseille, France. (Jan. 1990, p. 60)

* 15-19. **Tercer Congreso Nacional de Matemáticas**, San José, Costa Rica.

SPONSOR: Asociación Costarricense de Matemáticas.

CONFERENCE TOPICS: Pure and ap-

plied mathematics, mathematics education.

CALL FOR PAPERS: Abstracts by May 10, 1990.

INFORMATION: H. Barrantes, Escuela de Matemática, Universidad de Costa Rica, San José, Costa Rica; Tel: 53-7025; Fax: 34-0452.

- * 21-22. **Eastern Section, University of Massachusetts at Amherst, Amherst, MA.**

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

21-27. **Mathematische Methoden In Der Robotik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

21-27. **Arithmetik der Körper**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

21-27. **International Functional Analysis Meeting on the Occasion of the Sixtieth Birthday of Professor M. Valdivia**, Peñíscola, Spain. (Oct. 1989, p. 1098)

22-25. **Fifth Jerusalem Conference on Information Technology (JCIT-5)**, Jerusalem, Israel. (Jan. 1990, p. 60)

- * 26-27. **Statistical Mechanics at the 45th Parallel: Fourth Annual Meeting**, Université de Montréal, Canada.

ORGANIZER: C. Van Vliet (CRM).

INFORMATION: S. Chênevert or J. Roy, CRM, Université de Montréal, C.P. 6128-A, Montréal, Québec, H3C 3J7, Canada; 514-343-7501; Fax: 514-343-2254; email: crm@cc.umontreal.ca.

28-November 3. **Mathematical Economics**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

29-November 2. **Trieste Conference on Integrable Systems**, Trieste, Italy. (Jan. 1990, p. 61)

29-November 2. **Algorithmes Paralleles et Architectures Nouvelles**, Marseille, France. (Jan. 1990, p. 61)

29-November 16. **Workshop on Mathematical Ecology**, Trieste, Italy. (Jan. 1990, p. 61)

- * 31-November 3. **Latinamerican Seminar on Applications of Mathematics and Computer Science to Biology**, La Habana, Cuba.

SPONSORS: The National Center for Scientific Research of Cuba (CENIC) and the Latinamerican Society of ap-

plication of Mathematics and Computer Science to Biology.

PROGRAM: Scientific sessions will include conferences, contributed papers, workshops, and poster sessions.

CONFERENCE TOPICS: Mathematical models of biological systems, artificial intelligence in biological research, computer assisted molecular modelling, biological signal processing, image processing in biological research.

INVITED SPEAKERS: J. Demongeot (France), D. Castelle (France), F. Hirzebruch (F.R.G.), E. Clementi (U.S.A.).

CALL FOR PAPERS: Authors should send abstracts of their papers before May 31, 1990. Abstracts should have less than 150 words and shall include name and address of all authors and institutions involved. Acceptance letters will be sent before July 31, 1990.

INFORMATION: L. Sastre, Departamento de Matemática, Centro Nacional de Investigaciones Científicas, Apartado 6990, La Habana, Cuba; Telex: 51-1582 CNICA CU.

November 1990

2-3. **Central Section Meeting of the AMS**, University of North Texas, Denton, TX.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

4-10. **Wahrscheinlichkeitsmaße auf Gruppen**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

5-7. **Second SIAM Conference on Linear Algebra in Signals, Systems & Controls**, San Francisco, CA. (Sep. 1989, p. 920)

12-16. **Supercomputing '90**, New York, NY. (Sep. 1989, p. 920)

12-16. **Workshop on Representations of Reductive Groups over Finite Fields**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

18-24. **Komplexitätstheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. **Stochastische Approximation Und Optimierungsprobleme In Der Statistik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. **Lineare Modelle und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany.

(Jul./Aug. 1989, p. 769)

December 1990

2-8. **Multigrid Methods**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

3-5. **First International Symposium on Uncertainty and Analysis: Fuzzy Reasoning, Probabilistic Methods and Risk Management**, College Park, Maryland. (Apr. 1989, p. 1098)

- * 3-7. **Sixteenth Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, Palmerston North, New Zealand. (Please note change in date from Feb. 1989, p. 183)

3-7. **SINO-JAPANESE Joint Seminar on Nonlinear PDEs with Emphasis on Reaction-Diffusion Aspects**, Taipei, Taiwan. (Jan. 1990, p. 61)

3-7. **Workshop on General Group Representation Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

9-15. **Allgemeine Ungleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

16-22. **Mathematische Logik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-January 1. **Lineare Modelle Und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

January 1991

7-10. **Sixth Caribbean Conference on Combinatorics and Computing**, University of the West Indies, St. Augustine, Trinidad. (Jan. 1990, p. 61)

16-19. **Joint Mathematics Meeting**, San Francisco, CA. (including the annual meetings of the AMS, AWM, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

February 1991

25-March 1. **IEEE Computer Society COMPCON Spring '91**, San Francisco, CA. (Jan. 1990, p. 62)

New AMS Publications

New Series

The AMS is pleased to announce a new book series: The Conference Board of the Mathematical Sciences (CBMS): Issues in Mathematics Education Series published in cooperation with the Mathematical Association of America. The purpose of this new series is to stimulate the flow of information among mathematical scientists, mathematics educators, and mathematics teachers about innovative efforts to revitalize the teaching of mathematics and statistics at all levels. The inaugural volume of CBMS Issues in Mathematics Education is described below. Standing orders are accepted for any book series published by the Society. Proforma invoices are sent to standing order customers prior to the publication of each new volume. Shipment is made upon receipt of payment and publication. To begin a standing order for this new series or for any other AMS series, please contact Customer Services.

MATHEMATICIANS AND EDUCATION REFORM

Naomi Fisher, Harvey Keynes, and Philip Wagreich, Editors

(CBMS Issues in Mathematics Education, Volume 1)

Educational issues are receiving unprecedented attention in the broad mathematical sciences community, as mathematicians and other scientists have become concerned about the quality of instruction in the nation's schools, colleges, and universities. A mathematically literate population is crucial to supporting our increasingly technological society. In addition, the mathematical sciences community faces the challenge of increasing the number of students who are prepared to pursue a career in mathematics, science, or engineering. This challenge requires not only raising the quality of mathematics education, but also showing students the beauty and usefulness of the subject. In these ways, mathematical scientists can make crucial contributions to educational reform.

In response to these concerns, the Conference Board of the Mathematical Sciences has launched a new book series published by the American Mathematical Society in

cooperation with the Mathematical Association of America entitled Issues in Mathematics Education. The purpose of this new series is to stimulate the flow of information among mathematical scientists, mathematics educators, and mathematics teachers about innovative efforts to revitalize the teaching of mathematics and statistics at all levels.

The present volume, *Mathematicians and Education Reform*, the first in this new series, contains the proceedings of the Mathematicians and Education Reform workshop held in July 1988, at the University of Illinois at Chicago. The workshop provided an opportunity for participants to share ideas about the various ongoing precollege projects organized and directed by mathematicians and to reflect on the most effective ways that mathematicians can contribute to educational reform. The major part of the proceedings is devoted to in-depth articles that explore the process of designing an educational project. A section on issues and reactions presents a forum for exchanging ideas on more general issues.

From practical information about organizing a program to exploration of the intellectual issues of educational reform, this volume presents a range of views on various aspects of the involvement of mathematicians in educational change. While it will prove especially useful for those considering involvement in an educational program, this book is also important reading for the entire community, for the issues explored here will be of increasing importance for the future of the mathematical sciences.

Contents

Projects: The Challenge of Educating Mathematically Talented Students: The University of Minnesota Talented Youth Mathematics Program (UMTYMP)—**Thomas Berger** and **Harvey Keynes**; Teaching Mathematics to a Changing Population: The Professional Development Program (PDP) at the University of California at Berkeley—**Rose Asera**, **Philip Uri Treisman**; Teaching Integrated Math and Science: A Curriculum and Staff Development Project for the Elementary School—**Howard Goldberg** and **Philip Wagreich**; Improving College Readiness Through School/University Articulation—**Franklin Demana**; A Problem Solving Approach to Renewing Secondary Mathematics Teachers—**Thomas Berger** and **Harvey Keynes**; My Experience in Starting a Minority Program—**Bhushan L. Wadhwa**; The Geometry Teacher's "Do-It-Yourself" Kit—**Herbert Clemens**; Master Teachers as Teacher Role Models—**Joe Dan Austin**, **Elizabeth Herbert**, and **R. O. Wells, Jr.**; Issues and Reactions: Non-traditional Instruction in College Mathematics—**Roger H. Marty**; A Proposal for a Directory—**Klaus Fischer**; The Need to Recruit Women into Mathematics—**Jonell**

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COMPUTATIONAL ASPECTS OF VLSI DESIGN WITH AN EMPHASIS ON SEMICONDUCTOR DEVICE SIMULATION

Randolph E. Bank, Editor

(Lectures in Applied Mathematics, Volume 25)

Numerical simulation is rapidly becoming an important part of the VLSI design process, allowing the engineer to test, evaluate, and optimize various aspects of chip design without resorting to the costly and time-consuming process of fabricating prototypes. This procedure not only accelerates the design process, but also improves the end product, since it is economically feasible to numerically simulate many more options than might otherwise be considered. With the enhanced computing power of today's computers, more sophisticated models are now being developed.

This volume contains the proceedings of the AMS-SIAM Summer Seminar on Computational Aspects of VLSI Design, held at the Institute for Mathematics and Its Applications at the University of Minnesota, in the spring of 1987. The seminar featured presentations by some of the top experts working in this area. Their contributions to this volume form an excellent overview of the mathematical and computational problems arising in this area.

Contents

Peter A. Markowich, Spatial-temporal structure of solutions of the semiconductor device problem; **Christian Ringhofer**, The shape of solutions to the fundamental semiconductor device equations; **Franco Brezzi**, Singular perturbation analysis of (strongly) reverse biased semiconductor devices; **Pierre Degond, Frederic Poupaud, Bernard Niclot, and Frederique Guyot**, Semiconductor modelling via the Boltzmann equation; **Thomas I. Seidman**, The transient semiconductor problem with generation terms; **James L. Blue and Charles L. Wilson**, Modelling gallium arsenide transistors; **Mel S. Berger**, Nonlinear mathematical phenomena associated with semiconductor devices; **W. M. Coughran, Jr. and Joseph W. Jerome**, Modular algorithms for transient semiconductor device simulation, Part I: Analysis of the outer iteration; **Thomas Kerkhoven**, Efficiency and acceleration of steady-state decoupling algorithms; **Hans D. Mittelmann**, Continuation methods for parameter-dependent boundary value problems; **Linda R. Petzold**, Recent developments in the numerical solution of differential/algebraic systems.

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SOCIÉTÉ MATHÉMATIQUE DE FRANCE, ASTÉRISQUE

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LA PROPRIÉTÉ (T) DE KAZHDAN POUR LES GROUPE LOCALEMENT COMPACTS

de M. Burger

(Astérisque, Number 175)

A locally compact group G is said to have Kazhdan's property (T) if any isometric affine action of G in a Hilbert space has a fixed point. Typical examples of non compact groups with property (T) are $SL_n(\mathbb{R})$, $SL_n(\mathbb{Z})$ and $SL_n(\mathbb{Q}_p)$ for $n \geq 3$. The purpose of these notes is to show several equivalent definitions of this property, to give a large number of examples, and to point at several nice applications to discrete subgroups of Lie groups as well as to various problems of geometry and graph theory.

TABLE DES MATIÈRES

Définitions et premières conséquences; Principaux exemples: groupes de Lie: Le cas de $SL_n(\mathbb{R})$; Autres groupes de Lie simples à centres finis; Propriété (T) et revêtements; **Principaux exemples:** groupes discrets: Sous-groupes de Kazhdan d'un groupe de Kazhdan; Centre d'une partie bornée dans un espace métrique; L'inégalité de la médiane est vraie; A propos d'un théorème de Serre et de Gromov; **Définition cohomologique de la propriété (T):** Propriété (FH) de propriété (T); La famille $(H_i)_{i \geq 1}$ associée à un espace de Hilbert affine; **Propriété (T), fonctions de type positif et fonctions conditionnellement de type négatif:** Noyaux de type positif; Noyaux conditionnellement de type négatif; **Applications géométriques:** Arbres; Arbres réels; Complexes de Coxeter; Espaces hyperboliques; **Le problème de Ruziewicz:** Le problème de centraux téléphoniques: $Sp(1, n)$ est un groupe de Kazhdan ($n \geq 2$): Preuve du théorème A; Preuve du théorème B; Algèbres d'opérateurs.

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AMS Reports and Communications

Recent Appointments

Committee members' terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.

Richard Mandelbaum (1992) was appointed to the *Committee on Computer Operations and Facilities* by then chair of the Board of Trustees, M. Susan Montgomery. Peter J. Weinberger (1990) has been appointed chair. Continuing members of the committee are Ronald L. Graham (ex officio), and Jill P. Mesirov (1991).

M. Susan Montgomery, then chair of the Board of Trustees, appointed Murray Gerstenhaber as chair to the *Committee on Legal Aid*. Continuing members of the committee are Steve Armentrout and Todd Dupont.

Susan Friedlander (1992) was appointed to the *Committee on Membership* by then chair of the Board of Trustees, M. Susan Montgomery. Continuing members of the committee are Frederick W. Gehring (1990), chair, Melvin Henriksen (1990), Irwin Kra (1990), and Hugo Rossi (1991).

Robert L. Devaney (1992), and Eric Friedlander (1992) were appointed and Ramesh A. Gangolli (1992) and Andrew M. Odlyzko (1992) were reappointed by then chair of the Board of Trustees, M. Susan Montgomery, to the *Publishing Program Committee*. Professor Gangolli has also been appointed chair. Continuing members of the committee are Steve Armentrout (1990), Robert M. Fossum (ex

officio), William H. Jaco (ex officio), Mary C. Lane, consultant, Cathleen S. Morawetz (1991), John C. Polking (ex officio), and Paul J. Sally, Jr. (ex officio).

Carlos E. Kenig (1991) has been appointed by President William Browder to the *Editorial Boards Committee*. Continuing members of the committee are Linda Keen (1992), Haynes R. Miller (1990), Richard M. Schoen (1990), Barry Simon (1992), and Daniel Zelinsky (1991), chair.

President William Browder has appointed Alan D. Weinstein (1990) chair of the *Nominating Committee*. Other members of the committee are Joan S. Birman (1990), James E. Humphreys (1990), Barbara Lee Keyfitz (1992), Victor L. Klee, Jr. (1990), Ray Kunze (1992) and Robert Williams (1992).

Spencer Bloch (1992) has been appointed to the *Program Committee for National Meetings* by President William Browder and Jean Taylor (1992) has been appointed chair. Continuing members of the committee are James G. Arthur (1991), Robert M. Fossum (ex officio), Peter B. Gilkey (1990), George A. Hagedorn (1990), and Peter Sarnak (1991).

Carolyn S. Gordon (1991) and Robert Griess (1991) have been appointed by President William Browder to the *Central Section Program Committee*. Mark Mahowald (1990) has been appointed chair. Continuing members of the committee are Dennis A. Hejhal (1990), and Andy Roy Magid (ex officio).

President William Browder has appointed Richard N. Lyons (1991) to the *Eastern Section Program Com-*

mittee. Jerry L. Kazdan (1990) has been appointed chair. Continuing members of the committee are W. Wistar Comfort (ex officio), Detlef Gromoll (1990), and Walter A. Strauss (1990).

Michael Aschbacher (1991), and Michael G. Crandall (1991) have been appointed to the *Far Western Program Committee* by President William Browder. Sun-Yung Alice Chang (1990) has been appointed chair. Continuing members of the committee are Lance W. Small (ex officio) and John R. Stallings (1990).

Ronald F. Gariepy (1991) and Edward B. Saff (1991) have been appointed by President William Browder to the *Southeastern Section Program Committee*. William Pardon has been appointed chair. Continuing members of the committee are Joseph A. Cima (ex officio), and Ray Kunze (1990).

Karen Uhlenbeck and David A. Vogan, Jr. have been appointed by President William Browder to the *Committee to Select the Gibbs Lecturer for 1991 and 1992*. Elliott H. Lieb has been appointed chair.

Hyman Bass (1992) has been appointed to the *Progress in Mathematics Committee* by President William Browder. Continuing members of the committee are Armand Borel (1991), Paul H. Rabinowitz (1990), Hugo Rossi (1990), and Alan D. Weinstein (1991).

Ellis Kolchin (1992), Mary Ellen Rudin (1992), have been appointed and Gail S. Young (1992) has been reappointed by President William Browder to the *Committee on Academic Freedom, Tenure, and Employment Security*. Continuing members

of the committee are Thomas G. Kurtz (1990), Barbara L. Osofsky (1990), chair, and Charles E. Rickart (1991).

President William Browder has appointed Raymond Ayoub (1991), Joan S. Birman (1992), Chandler Davis (1991), Cora S. Sadosky (1992), and Steven H. Weintraub (1992) to the *Committee on Human Rights of Mathematicians*. Continuing members of the committee are Michael I. Brin (1990), Joel Lebowitz (1990), and Alice T. Schafer (1990), chair.

Henry Alder (1990), Rhonda J. Hughes (1991), Ivan Niven (1990), Eileen Poiani (1992), Bruce Reznick (1990), Carol L. Walker (1991), and Carol S. Wood (1992) have been appointed to the *Pi Mu Epsilon Liaison Committee* by President William Browder. Professor Walker will serve as chair.

Everett Pitcher (1992) has been appointed chair of the *Committee on Professional Ethics* by President William Browder. Continuing members of the committee are C. Edmund Burgess (1990), Harold M. Edwards (1991), Frank L. Gilfeather (1990), and George B. Seligman (1991).

President William Browder has appointed Joseph J. Kohn (1992), Joel L. Lebowitz (1992), Paul J. Sally, Jr. (1992), and Mary F. Wheeler (1992) to the *Science Policy Committee*. Michael C. Reed (1992) has been appointed chair. Other members of the committee are Michael Artin (ex officio), Hyman Bass (1990), William Browder (ex officio), Frank L. Gilfeather (1990), William H. Jaco (ex officio), Jerrold E. Marsden (1991), Cathleen S. Morawetz (1991), John C. Polking (1990), Oscar S. Rothe (1991), and David A. Vogan, Jr. (1991).

Charles Herbert Clemens, Samuel Gitler, Carlos E. Kenig, Joseph J. Kohn, Horacio A. Porta, Cora S. Sadosky, and David A. Sanchez have been appointed by President William Browder to an ad hoc *Committee on Cooperation with Latin American Mathematicians*. Professor Clemens will serve as chair.

Ronald G. Douglas, Robert M. Fossum (ex officio), John C. Polking, David P. Roselle, and David A. Sanchez have been appointed to the *Committee to Select the Winner of the Award for Public Service* by President William Browder. Professor Fossum will serve as chair.

Dusa McDuff (1991), Alexander J. Nagel (1991), and Karl Rubin (1991) have been appointed by President William Browder to the *Committee on Centennial Fellowships*. Karen A. Vogtmann (1990) has been appointed chair. Continuing members of the committee are David Eisenbud (1990), Lawrence Craig Evans (1990), and Victor L. Klee, Jr. (1990).

Sylvia T. Bozeman (1992), Claudette Bradley (1992), and Johnny E. Brown (1992) have been appointed by Presidents William Browder (AMS) and Lida K. Barrett (MAA) to the *AMS-AAAS-MAA Committee on Opportunities in Mathematics for Underrepresented Minorities*. Gloria F. Gilmer (1992) has been appointed chair. Continuing members of the committee are Shirley Malcom (ex officio), and Argelia Veléz-Rodríguez, consultant.

William Abikoff, Hyman Bass, and Robert M. Fossum have been appointed by President William Browder to the *AMS-LMS Joint Program Committee*.

The Data Subcommittee has split

off from the AMS-MAA *Committee on Employment and Educational Policy* and is now a standing joint committee called the *AMS-MAA Data Committee*. Presidents William Browder (AMS) and Lida K. Barrett (MAA) have appointed Edward Connors (AMS, 1990), John D. F. Ton (MAA, 1991), James F. Hughes (AMS, 1991), Charlotte Lin (AMS, 1992), Don O. Loftsgaarden (MAA, 1990), David J. Lutzer (MAA, 1992), Donald E. McClure (AMS, 1992), and Donald C. Rung (AMS, 1992) to the committee. Lincoln K. Dursi is a consultant and James W. Maxwell (AMS) serves as ex officio. Professor Connors will serve as chair.

Morton Brown (MAA, 1992), David J. Lutzer (MAA, 1992), and Bernard L. Madison (AMS, 1992) have been appointed by Presidents William Browder (AMS) and Lida K. Barrett (MAA) to the *AMS-MAA Committee on Employment and Educational Policy*. Continuing members of the committee are Donna B. Brown (AMS, 1991), Edward A. Connors (AMS, 1991), chair, Philip C. Pappas, Jr. (MAA, 1990), James W. Maxwell (ex officio), and James J. Tattersall (MAA, 1990).

Presidents William Browder (AMS) and Lida K. Barrett (MAA) have appointed Edward A. Connors (AMS, 1991), Steve Dobbin (MAA, 1991), Don R. Lick (MAA, 1991), and Shelba J. Morman (MAA, 1991) to the *AMS-MAA Committee on Teaching Assistants and Part Time Instructors (TA/PTI)*. John P. H. Jones (MAA, 1992) has been appointed chair. Continuing members of the committee are Thomas F. Banchoff (AMS, 1992), Thomas T. Read (AMS, 1991), and Robert H. Szczerba (AMS, 1990).

Miscellaneous

Personal Items

Duncan A. Buell, director for algorithms research at the Supercomputing Research Center, Institute for Defense Analyses, in Bowie, Maryland, will serve as a volunteer in a new program called Institute for Middle School Science and Mathematics Teachers. In the program, sponsored by Bell Atlantic and the American Association for the Advancement of Science, forty participating teachers will team up with practicing scientists to improve science and mathematics education.

David Gilat, of Tel Aviv University, has been promoted to Associate Professor of that institution.

Hans G. Kaper, director of the Mathematics and Computer Science Division at Argonne National Laboratory, has been named a corresponding member of the Royal Dutch Academy of Sciences.

Mokhtar Hassan Konsowa, of the University of Cincinnati, has been appointed an Assistant Professor at the College of Business and Economics, King Saud University, AL Qasseem Branch in the Kingdom of Saudi Arabia.

Harald Niederreiter, of the Austrian Academy of Sciences in Vienna, has been appointed director of the Institute for Information Processing at that Academy.

Hugo Rossi, Dean of the College of Science at the University of Utah, has been appointed director of the Cold Fusion Project at that institution.

Deaths

John Brode, of SimuLogics, Cambridge, Massachusetts, died on September 9, 1989, at the age of 57. He was a member of the AMS for 10 years.

Reuven H. Gurevic, of the University of Wisconsin, died on October 9, 1989, at the age of 37. He was a member of the AMS for 9 years.

Arthur O. Hickson, Professor Emeritus of Duke University, died on October 14, 1989, at the age of 93. He was a member of the Society for 66 years.

Stephanie F. Troyer, of the University of Hartford, died on November 1, 1989, at the age of 45. She was a member of the Society for 17 years.

Visiting Mathematicians

Arpad Takači and Djurdjica Takači, from the Institute of Mathematics at Novi Sad, Yugoslavia, are spending the 1989-1990 academic year at Virginia Commonwealth University, Richmond, Virginia.

Some Mathematical Questions in Biology: MODELS IN POPULATION BIOLOGY

Alan Hastings, Editor

(Lectures on Mathematics in the Life Sciences, Volume 20)

Population biology has had a long history of mathematical modeling. The 1920s and 1930s saw major strides with the work of Lotka and Volterra in ecology and Fisher, Haldane, and Wright in genetics. In recent years, much more sophisticated mathematical techniques have been brought to bear on questions in population biology. Simultaneously, advances in experimental and field work have produced a wealth of new data. While this growth has tended to fragment the field, one unifying theme is that similar mathematical questions arise in a range of biological contexts.

This volume contains the proceedings of a symposium on Some Mathematical Questions in Biology, held in Chicago in 1987. The papers all deal with different aspects of population biology, but there are overlaps in the mathematical techniques used; for example, dynamics of nonlinear differential and

difference equations form a common theme. The topics covered are cultural evolution, multilocus population genetics, spatially structured population genetics, chaos and the dynamics of epidemics, and the dynamics of ecological communities.

1980 *Mathematics Subject Classifications*: 92A10, 92A15
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PRIMES ASSOCIATED TO AN IDEAL

Stephen McAdam

(Contemporary Mathematics, Volume 102)

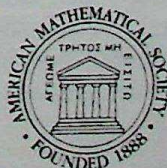
This book discusses five closely related sets of prime ideals associated to an ideal I in a Noetherian ring: the persistent, asymptotic, quintasymptotic, essential, and quintessential primes of I . Since the appearance of the author's last book on the subject, which focused on the first two of these prime ideals, the other three sets were developed and new results were obtained for the first two. Current results are scattered over some three dozen papers, making it difficult for interested readers to become familiar with the subject.

The aim of this book is to present in an efficient way the most important and interesting ideas in the subject and to show how these prime ideals reveal information about both I and the ring. Because the required background consists of little more than a standard one-year course in commutative ring theory, the book should be accessible to graduate students. The work is primarily intended for commutative ring theorists, but noncommutative ring theorists and algebraic geometers may also find it of interest.

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The salary will be within the range for non-clinical professorial salaries, currently not less than £25,919 per annum.

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IOWA STATE UNIVERSITY

The Department seeks qualified applicants for tenure track positions at the assistant professor level in Discrete Mathematics and in Mathematical Biology and for a tenure track position at the associate or full professor level in Computational Mathematics or Numerical Analysis starting August 21, 1990. The successful applicant for the senior position will be expected to seek outside funding for his or her research and to interact scientifically with colleagues in other campus departments. There will be start up funds available for the successful applicant for each of the three positions.

We will begin the interview process January 15, 1990. However, we shall continue to accept applications after that date until the positions are filled.

A number of visiting positions in diverse areas are expected to be available also and applications for them are also encouraged.

Women and minorities are encouraged to apply. Iowa State University is an Affirmative Action/Equal Opportunity Employer.

Applications should be sent to Howard A. Levine, Chair, Department of Mathematics, Iowa State University, Ames, Iowa 50011.

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The Department of Mathematics at North Carolina State University in Raleigh invites applications for the position of Research Instructorship in Pure Mathematics. This appointment will be for 2 years (with a possible extension for a third year) and will require teaching of two courses in the fall semester and one course in the spring semester.

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Applicants should send a description of their research (1-3) pages, curriculum vitae and 3 letters of recommendation to Professor R. O. Fulp, Box 8205, N.C. State University, Raleigh, NC 27695-8205. To ensure full consideration applications should be received by March 15, 1990. NCSU is an AA/EOE.

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Highly motivated applied mathematicians are invited to apply for the above posts commencing on or before September 1990. Baptist College is a government-funded institution with a student body of 3000. The Mathematics Department offers a comprehensive B.Sc. (Honours) curriculum and M.Phil. by research. Typical teaching load is two subjects (6 hours) per semester plus supervision of 4 final year project students. The atmosphere is congenial, and interdisciplinary collaboration is encouraged. Qualifications for Lecturer are a Ph.D., teaching experience, and research promise. Applicants for Principal Lecturer should have extensive teaching and research experience and the ability to provide academic leadership. Applicants with expertise in any area of applied mathematics are encouraged to apply—especially statisticians. Salary (under review) is US\$46,070-US\$57,185 p.a. for Principal Lecturer and US\$24,485-US\$37,155 p.a. for Lecturer. Benefits include housing assistance, medical/dental benefits, education allowance for children, passage and vacation leave. Overseas appointees will be offered an initial 2-year contract with 15-25% gratuity payable at the end of the contract. Appointment may be renewed subject to mutual agreement. To apply send complete curriculum-vitae and three letters of reference to the Personnel Section, Hong Kong Baptist College, 224 Waterloo Road, Kowloon, Hong Kong. Deadline for applications is February 15, 1990 or until vacancies have been filled.

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Tenure track position anticipated in mathematics and computer science. Candidate must have an earned doctorate, a strong commitment to teaching and a demonstrated outstanding research potential. Rank and salary commensurate with qualifications. Send resume and names of three references to:

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ACTION EMPLOYER

UNIVERSITY OF CALIFORNIA RIVERSIDE Announcement Chairperson and Professor Department of Mathematics

The College of Natural and Agricultural Sciences invites applications and nominations for the position of Chairperson and Professor of the Department of Mathematics, effective July 1, 1990. The department is responsible for both undergraduate and graduate teaching in one of the fastest growing universities in the country. Currently the department has twenty-eight full-time faculty with emphasis in algebra, geometry, topology, and analysis combinatorics. There are 106 undergraduate majors and 36 graduate students.

Preference will be given to candidates capable of providing leadership in both the department and profession and in representing the faculty's perspective in the college enhancing faculty performance and extramural support and connecting the various program interests in computing with a new College of Engineering. Candidates for the position should have the following qualifications: an earned doctorate in mathematics; a distinguished record of scholarship, teaching and service appropriate for the appointment as full professor; demonstrated administrative skills; and a strong commitment to academic values and the principles of affirmative action.

The chairperson reports to the Dean of the College of Natural and Agricultural Sciences and is responsible for providing leadership and representing faculty in matters such as teaching, personnel, and budget. Chairpersons are appointed for up to five years and may be reviewed. Salary will be commensurate with qualifications and experience. The faculty appointment is a nine-month position with additional compensation for duties of chairperson. The closing date for applications will be February 15, 1990. A letter of intent along with a curriculum vitae, and the names, addresses and phone numbers of at least three references should be sent to:

Dr. Seymour D. Van Gundy
Interim Dean, College of Natural and
Agricultural Sciences
University of California Riverside
Riverside, CA 92521

The University of California, Riverside is an Equal Opportunity, Affirmative Action employer. Women and Minorities are encouraged to apply.

POSITIONS AVAILABLE

THE UNIVERSITY OF OKLAHOMA Department of Mathematics

Applications are invited for one or more positions at the Assistant Professor level (or higher) in Mathematics beginning Fall 1990. Candidates must have a Ph.D. degree, demonstrated excellence in research, and potential for high-quality teaching. Strong candidates in all areas will be considered, with preference given to research interests compatible with those of our current faculty. Duties include research, normally teaching six credit hours per semester, and Departmental and University service appropriate to rank. Salary and rank will be commensurate with qualifications and experience. There may also be visiting positions. Applicants should send their vita and have at least three letters of reference sent to Dr. Ruediger Landes, Search Committee Chair, Department of Mathematics, University of Oklahoma, 601 Elm, Room 423, Norman, Oklahoma 73019-0315. Initial screening begins December 15, 1989 and every two weeks thereafter. Applications will be accepted until the position(s) are filled. The University of Oklahoma is an Affirmative Action/Equal Opportunity Employer.

NORTHERN MICHIGAN UNIVERSITY DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

The Mathematics and Computer Science Department invites applications for an anticipated temporary position at the rank of Assistant Professor. All specialties welcome—mathematics, mathematics education, statistics, and computer science.

Northern is primarily an undergraduate institution and a commitment to teaching is an essential requirement for the positions. Scholarship and professional activity are both encouraged and supported.

Applicants should send a resume, transcripts, and three letters of reference to Dr. Terrance Seethoff, Head, Department of Mathematics and Computer Science; Northern Michigan University; Marquette, MI 49855.

Northern Michigan University is an equal opportunity, affirmative action employer.

THE UNIVERSITY OF OKLAHOMA Applied Non-Linear Analysis Applied Mathematics Position (CAPS) Related

The University of Oklahoma seeks a (tenure track) Assistant Professor (or higher) with a speciality in Applied Non-Linear Analysis. A Ph.D. in Mathematics is required. Expertise in fluid dynamics and numerical and computational experience are desirable. Potential for excellence in mathematics teaching and research is required. Competitive Salary.

This position is expected to contribute to the mathematical support of the Center for the Analysis and Prediction of Storms, A Science and Technology Center at the University of Oklahoma funded by the National Science Foundation.

Applicants should send a letter of application, a complete vita, and have three letters of reference sent to: Andy R. Magid, Chair, Applied Analysis Search Committee, Department of Mathematics, University of Oklahoma, 601 Elm, Room 423, Norman, Oklahoma 73019-0315. Closing date for applications is December 20, 1989 and every two weeks thereafter until the position is filled. The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

AUBURN UNIVERSITY DIVISION OF MATHEMATICS DEPARTMENT OF FOUNDATIONS, ANALYSIS, AND TOPOLOGY

We anticipate having at least two visiting positions available for the 1990-91 academic year. Partial appointments are also possible. The applicant's area of research should be compatible with the interests of present faculty. Closing date for applications: March 31, 1990.

Send vita and have three letters of recommendation sent to George Kozlowski, Head, Department of Foundations, Analysis, and Topology, AUBURN UNIVERSITY, AL 36849-5310.

Minorities and women are encouraged to apply.

AUBURN UNIVERSITY IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.

UNIVERSITY OF MARYLAND COLLEGE PARK DEAN

College of Computer, Mathematical and Physical Sciences

Applications and nominations are invited for the position of Dean of the College of Computer, Mathematical, and Physical Sciences at the University of Maryland, College Park campus. The Dean provides both academic and administrative leadership for the College and reports directly to the Vice Chancellor for Academic Affairs and Provost.

The College consists of the departments of Computer Science, Geology, Mathematics, Meteorology, and Physics and Astronomy, as well as the Applied Mathematics Program, the Center for Automation Research, the Chemical Physics Program, the Institute for Physical Science and Technology, the Institute for Advanced Computer Studies, and the Laboratory for Plasma Research. The College employs 472 faculty members and approximately 800 support personnel. Presently about 2300 undergraduate students and 800 graduate students are enrolled in degree programs within the College. In 1988-89, researchers in the College were awarded approximately \$34 million in external grants and contracts. The state-supported budget was about \$28 million.

A candidate should have an earned doctorate, be eligible for appointment in a department of the College at the rank of Professor with tenure, have successful experience as a teacher and a distinguished record of scholarly research, and have demonstrated leadership ability and management skills.

Applications should include a curriculum vitae and the names and addresses of at least four references. For best consideration, all applications should be submitted before March 1, 1990 to:

Patrick F. Cunniff
Office of Graduate Studies & Research
2125 Lee Building
University of Maryland
College Park, Maryland 20742

The University of Maryland is an equal opportunity, affirmative action employer. Women and minority candidates are encouraged to apply.

POSITIONS AVAILABLE

MISSISSIPPI STATE UNIVERSITY Department of Mathematics and Statistics

Applications are invited for two or more anticipated tenure-track or visiting positions for 1990-91. At least one of the positions will be in statistics and probably at least at the associate professor level. Candidates should possess a doctoral degree, demonstrate a strong potential for research, and have a commitment to effective teaching. All areas are welcomed but preference will be given to the following: for the mathematics position(s), applied mathematics, computational mathematics, and partial differential equations; for the statistics position(s), multivariate analysis, non-parametric and robust inference, categorical analysis, and linear and non-linear models.

The Department offers graduate programs leading to the Master of Arts degree (M.A.) and the Master of Science degree (M.S.) in both mathematics and statistics and the Doctor of Philosophy degree (Ph.D.) in mathematical sciences. Facilities exist for applicants with interest in interdisciplinary research efforts and in particular for applicants with an interest in the computational aspects of the mathematical sciences.

Applicants should send a curriculum vitae and arrange for three letters of recommendation to be sent to: John R. Gilbert, Chairman, Search Committee, Department of Mathematics and Statistics, P.O. Drawer MA, Mississippi State, MS 39762. The committee will begin to review applications on January 15, 1990, and continue until positions are filled. Mississippi State University is an equal opportunity/affirmative action employer.

UNIVERSITY OF VERMONT Positions in Applied Mathematics

Positions for applied mathematicians, tenure-track or visiting. Salary and rank commensurate with ability and experience. Demonstrated excellence in research and teaching, interaction with other scientists and engineers. Also, postdoctoral positions in subjects of current departmental interest. Send vitae, description of research, and three letters of reference or names of references to Kenneth I. Gross, Personnel Committee, Department of Mathematics and Statistics, University of Vermont, Burlington, VT 05405. UVM is an Equal Opportunity/Affirmative Action Employer.

COLUMBIA UNIVERSITY Department of Computer Science Lectureships

Positions as Lecturer or Senior Lecturer will be offered to excellent teachers with superior research and academic backgrounds. Faculty of all ranks in other mathematical disciplines, as well as computer science, are encouraged to apply for these non-tenured term appointments, whose duration will typically be three to six years. Pay is comparable to professorial levels.

These lectureships provide an opportunity for teacher/scholars with some substantial prior computing experience to make a transition to computer science. Columbia University has an outstanding young research faculty and facilities, now working in a five-million dollar office and research-laboratory building. All of our "lecturer alumni" are presently in good positions at leading universities and colleges.

Lecturers will teach two undergraduate courses each semester. They must be able to make highly effective presentations to large classes. The University has several SUN 4 computer systems dedicated to instructional use. Many terminals for students are in dormitories and other convenient locations. Knowledge of innovative uses of technology for teaching is desirable.

Send resume and three letters of reference by February 15, 1990, if possible, to Lecturer Recruiting, Department of Computer Science, Columbia University, New York, New York 10027.

Columbia University is an Equal Opportunity/Affirmative Action Employer. We are interested in receiving applications from qualified women and minorities.

MARQUETTE UNIVERSITY

Mathematics/Statistics/Computer Science. Tenure-track Assistant Professorship requiring the Ph.D. to begin August, 1990. Preferred research area is computational group theory, and ability to teach upper division computer science courses is required. To apply send vita, transcripts and 3 letters of recommendation to Douglas Harris (Chairman), Department of Mathematics, Statistics and Computer Science, Marquette University, Milwaukee, Wisconsin, 53233. Closing date: February 28, 1990 or until filled. Marquette University is an EEO/AA employer.

THE CLARE BOOTHE LUCE FACULTY CHAIR AT CREIGHTON UNIVERSITY in Mathematics/Computer Science

Creighton University invites applications from outstanding women candidates for appointment to the Clare Boothe Luce Faculty Chair in the Mathematics/Computer Science Department.

Candidates are expected to be excellent scholar/teachers who will serve as mentors and role models for undergraduate women interested in careers in scientific research. The Department will consider candidates in Mathematics, Statistics, or Computer Science. Candidates are expected to be interdisciplinary in approach and committed to a productive research program. The successful candidate will be expected to teach in the general mathematics/computer science/statistics program and in her area of specialization, and to develop an active research program involving undergraduate and graduate students. The initial appointment at the Assistant Professor level, is renewable annually up to a total of five years. Salary is commensurate with the capabilities of an outstanding scholar/teacher.

Interested women should send a letter of intent, a curriculum vitae, official transcripts, three letters of reference, a statement of current research interests and achievements, and information on teaching experience for success. Materials should be mailed to the search committee by a 15 February 1990 deadline. Please address applications and inquiries to: The Search Committee, Dean's office, College of Arts and Sciences, Creighton University, 24th Street, Omaha, NE 68178.

Creighton University is an equal opportunity, affirmative action employer.

SYRACUSE UNIVERSITY Department of Mathematics

We anticipate positions available at the Assistant and Associate Professor levels beginning Fall 1990. Candidates should have outstanding research ability and evidence of excellence in teaching. Applications are invited in any area of mathematics, statistics, mathematics education and vita with a list of application and vita with a list of publications and three references to: Seymour Waterman, Chair, Syracuse University, Department of Mathematics, Box 1, Syracuse, NY 13244-1150.

POSITIONS AVAILABLE

THE UNIVERSITY OF NEW MEXICO

Albuquerque, New Mexico

Department of Mathematics and Statistics

The Department expects to have four tenure track positions available, beginning in the Fall Semester, 1990. We are particularly interested in candidates at the assistant professor level with postdoctoral experience, but we will consider outstanding applicants at all levels. Candidates must have a strong research record or outstanding potential and a commitment to excellence in teaching.

The Department of Mathematics and Statistics currently has 40 faculty members and an active and expanding graduate program. The Department has close research ties with Los Alamos and Sandia National Laboratories, and access to major computing facilities. Joint appointments with other departments are possible.

Review of applications will begin January 15, 1990, and will continue until the positions are filled. All exceptionally strong candidates, especially women and minority group members, are urged to apply. Please have vitae and three letters of reference sent to:

Professor Robert Cogburn, Chair
Hiring Committee
Dept. of Mathematics & Statistics
The University of New Mexico
Albuquerque, NM 87131

THE UNIVERSITY OF NEW MEXICO IS AN
AA/EEO.

KENNESAW STATE COLLEGE

Mathematics Department
P.O. Box 444

Marietta, GA 30061

At least one tenure track position in Mathematics at the level of Assistant Professor beginning in September, 1990. A Ph.D. is required with a strong commitment to undergraduate education as well as an interest in scholarly activities. Preference will be given to degrees in Combinatorial Group Theory, Combinatorics, or Statistics. Salary and rank are competitive and commensurate with credentials and experience. The College is located in Northwest Metro Atlanta, and enrolls over 9000 day and evening students in undergraduate and graduate programs. The Department of Mathematics has 18 full-time faculty and shares 6 others with the Department of Computer Science. Send resume and a list of three references to Dr. Nancy E. Zumoff, Chair, Search Committee. Application deadline is March 1, 1990, or until filled (EOE/AA).

MISSISSIPPI STATE UNIVERSITY ADVERTISEMENT

Position Announcement

Head, Department of Computer Science

Mississippi State University invites applications and nominations for the position of head of the Department of Computer Science. A successful candidate must have (1) an earned doctorate in computer science or related field, an (2) faculty experience in a doctoral granting program. In addition, candidates should have demonstrated leadership and a successful record of teaching, research, and grant procurement. The appointment will be at the rank of professor with a highly competitive salary. The anticipated starting date is July 1, 1990.

As one of the 100 largest research universities (expenditures) in the country and the largest university in the state, MSU offers a broad range of undergraduate and graduate programs. The Department of Computer Science offers a CSAB-accredited undergraduate program and graduate study leading to the MCS, MS and PhD degrees. In cooperation with electrical engineering, the department also offers programs of study leading to the BS and MS degrees in computer engineering.

Screening of candidates will begin February 15, 1990 and will continue until the position is filled. Nominations and applications with curriculum vita should be sent to: Dr. George S. Rent, Chairperson, Search Committee for Head of Computer Science, College of Arts and Sciences, P.O. Box AS, Mississippi State, MS 39762. MSU is an equal opportunity affirmative action employer.

FLORIDA INTERNATIONAL UNIVERSITY

The State University of Florida at Miami

The Department of Mathematics announces two junior tenure track positions beginning August 1990. Candidates must have a Ph.D. in Mathematics and a commitment to research and quality teaching. Preferred areas of specialization include harmonic analysis, logic, representation theory, complex variables, and differential geometry. Qualified candidates in other areas will be considered.

Teaching load consists of 15 semester hours per academic year. Send resume and 3 letters of recommendation to Recruitment Committee, Department of Mathematics, Florida International University, Miami, FL 33199.

Florida International University is the State University of Florida at Miami. The university is an equal opportunity/affirmative action employer.

THE VIRGINIA MILITARY INSTITUTE Mathematics/Computer Science

Applications are invited for a tenure-track position in the Mathematics and Computer Science Department beginning August, 1990. The applicant should have a strong interest in teaching and participating in the continued development of the computer science degree program. VMI began offering a B.S. in computer science in 1987 and now has 57 students either as majors or minors. The computer science laboratory contains a Data General MV/7800 with 20 terminals. VMI also has a Burroughs A9 and approximately 200 IBM PC's for student and faculty use.

Preference will be given to an applicant with a Ph.D. in a computer-related field such as Computer Science, Mathematics, Operations Research, or Management Information Systems. If the degree is not in Computer Science, the applicant must have significant formal education or experience in Computer Science. Duties include teaching both mathematics and computer science courses. Salary and rank are commensurate with degrees, qualifications, and experience.

VMI is a quality undergraduate military college of engineering, liberal arts, and science, with an enrollment of 1300 students, located in an attractive college town. Faculty wear uniforms but have no other assigned military duties.

The deadline for applications is March 1, 1990. Candidates should send resumes with at least three references to Thomas C. Lominac, Department of Mathematics and Computer Science, Virginia Military Institute, Lexington, VA 24450

AA/EEO Employer.

UNIVERSITY OF CALIFORNIA IRVINE DEPARTMENT OF MATHEMATICS IRVINE, CALIFORNIA

The Department of Mathematics announces possible temporary positions for lecturers for the academic year 1990-91. These positions are generally for one quarter at a time and at varying percentages depending on the number and nature of courses assigned to be taught. Masters degree in Mathematics and a good teaching record are required. Send enquiries to Chair, Department of Mathematics, University of California, Irvine, CA 92717.

UCI is an equal opportunity/affirmative action employer.

POSITIONS AVAILABLE

RUTGERS UNIVERSITY-NEWARK DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE SENIOR POSITION PROFESSOR OF MATHEMATICS SEARCH EXTENDED

The Department of Mathematics and Computer Science anticipates an opening at the full professor level beginning Fall 1990. Rutgers University has two levels of full professorships and the appointment will either carry the rank of Professor I or Professor II. Candidates should exhibit outstanding research accomplishments and should be able to play a leadership role in the department. Salary and teaching load are negotiable. Applicants from all fields are invited. Areas of research interest in the department include number theory, representation theory and automorphic forms, Lie algebras, transformation groups, low dimensional topology and Teichmüller theory. Applications including at least three letters of recommendation should be sent to: Jane Gilman, Chair, Department of Mathematics, Rutgers University, Newark, New Jersey 07102. The closing date for applications is 3/1/90 but applications will be considered until the position is filled.

AA/EOE.

WORCESTER POLYTECHNIC INSTITUTE

The Department of Mathematical Sciences will have several tenure track positions at all levels for fall of 1990. These positions require a strong research record or potential and evidence of quality teaching. Fields of interest are numerical analysis, computational fluid mechanics, nonlinear PDE, optimization, control theory, optimal design, dynamical systems, applied discrete mathematics, operations research, and statistics/applied probability.

WPI, the nation's third oldest college of science and engineering, offers degrees through the Ph.D. The Mathematical Sciences Department currently offers an undergraduate and master's degree in applied mathematics. Worcester, Massachusetts is the second largest city in New England, approximately 40 miles west of Boston.

Interested applicants should send a curriculum vita to: Samuel M. Rankin, III, Head, Department of Mathematical Sciences, 100 Institute Rd., Worcester, MA 01609. Applications will be accepted until the positions are filled. EOE/AA.

THE UNIVERSITY OF MANITOBA ANNOUNCEMENT OF STATISTICS POSITION

The Department of Statistics, The University of Manitoba, invites applications for a term position at the assistant professor level. The appointment will be for a two year term, starting July 1, 1990 or September 1, 1990. The salary will be commensurate with qualifications and experience. A Ph.D. or near completion in statistics or probability theory is required, and duties will include research, teaching and consulting. Preference will be given to candidates who have a strong research potential.

Please send your application as soon as possible, but not later than February 15, 1990, to:

Dr. Lai K. Chan
Department of Statistics,
The University of Manitoba
Winnipeg, Manitoba, Canada
R3T 2N2

Your application should include an updated curriculum vitae and the names of three individuals who would be prepared to write letters of recommendation.

Both women and men are encouraged to apply. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents.

WESTERN CAROLINA UNIVERSITY

Nominations and applications are invited for the position of Head, Department of Mathematics and Computer Science. The department has eighteen full time faculty members and offers programs leading to the B.S., B.S. Ed., M.S., and M.A. Ed. degrees with majors in mathematics, and the B.S. degree with a major in computer science. Western Carolina University has an enrollment of 6200 and is a member of the University of North Carolina system. The successful candidate should have a terminal degree, a sustained record of quality teaching, research, and service, and an interest in both undergraduate and graduate program development, as well as administrative experience and/or potential.

Applicants should send a resume, graduate transcripts, and three letters of reference to: Dr. James H. Horton, Chair, Mathematics and Computer Science Search Committee, School of Arts and Sciences, Western Carolina University, Cullowhee, NC 28723. WCU is an Equal Opportunity/Affirmative Action Employer. Closing date for receipt of applications is March 1, 1990.

RICE UNIVERSITY Mathematical Sciences Department P.O. Box 1892, Houston, Texas 77251

Applications are invited for a tenure-track assistant professor position to start August 1989 in energy and environmental applications of mathematics. Applicants should demonstrate both breadth of interest and promise in research and teaching. We especially invite applications in numerical linear algebra, mathematical programming, and numerical solutions of partial differential equations.

Rice University is a private research university with a long tradition of excellence in undergraduate science and engineering education. The Mathematical Sciences Department also hosts an active and expanding graduate program, has superb computing facilities and ongoing research in Operations Research, Computational Mathematical Programming, and Optimal Design and Inverse Problems for Partial Differential Equations. The department has excellent relations with other departments at Rice and the University of Houston, with industrial and government research groups, and is actively involved in the Center for Research in Parallel Computing which is funded by the NSF Science and Technology Centers program.

Please furnish vita, transcripts, reports, and three letters of recommendation to: E. Dennis, Chair, Staffing Committee. Rice University is an Affirmative Action/Equal Opportunity Employer.

UNITED STATES AIR FORCE ACADEMY DEPARTMENT OF MATHEMATICAL SCIENCES VISITING PROFESSOR

The Department of Mathematical Sciences at the United States Air Force Academy invites nominations and applications for a Visiting Professor position. We seek a Professor with extensive experience teaching undergraduate mathematics, statistics or operations research and a strong record of scholarly activities. Duties will include reviewing our academic programs, teaching undergraduate courses, promoting our research programs. Applicants should have a demonstrated commitment to undergraduate research and education. Appointment is usually for one year and begins in July 1991. Inquiries are welcome. Visiting Professor positions for subsequent years. Salary is commensurate with qualifications. To apply, please send nominations (to include resume and references) by March 1, 1990 to: Chairman, Department of Mathematical Sciences, United States Air Force Academy, CO 80840-5701.

POSITIONS AVAILABLE

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM DEPARTMENT OF MATHEMATICS

Applications are invited for one or more anticipated tenure or tenure-track positions. Preference will be given to strong candidates whose research interests are compatible with those of our current faculty; this includes numerical PDE/Scientific computation, mathematical physics, partial differential equations, nonlinear analysis, dynamical systems, including topological dynamics, and differential geometry. Faculty members have access to the Alabama Super Computer (using a Sun Station and a T-1 line to a Cray X-MP/24). Rank and salary will be subject to qualifications, but applicants for senior positions must have demonstrated excellence in research, while applicants for junior positions must exhibit the promise of excellence. Send as soon as possible a curriculum vita, selected reprints, and three letters of reference (candidates for senior positions may choose to submit a list of references instead) to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/Equal Opportunity Employer.

HANOVER COLLEGE

Mathematics: Tenure track position beginning Sept., 1990. The Mathematics Department of Hanover College offers standard courses for majors and a large number of classes for science, economics and business students and for candidates for teacher certification. The department will also oversee a mathematics "learning center" now being organized. Candidates should thus be skilled at communicating mathematical ideas to students for varying sophistication in the field. They should also be committed to teaching in the tradition of the liberal arts at a selective, independent, Presbyterian college. Rank and salary dependent on qualifications and experience. Applications, vitae, transcripts, and at least three letters of reference to Charles L. Flynn, Dean of the College, Hanover College, Hanover, Indiana 47243. EEO/AA employer committed to building a culturally pluralistic faculty and student body.

MURRAY STATE UNIVERSITY Department of Mathematics & Statistics

Applications are invited for tenure-track positions at the Assistant/Associate Professor level beginning August 1990. Preference will be given the applicants in statistics, numerical analysis, and mathematics education, but candidates in all areas of mathematics will be considered.

Responsibilities will include a maximum three course teaching load of a wide variety of undergraduate and graduate level courses, continuing research/scholarly activities, and university/departmental service. A Ph.D. in mathematics or statistics is required or expected before the starting date. Salary will be competitive. Screening will begin February 1, 1990 and continue until positions are filled.

Applicants who are not U.S. citizens must provide their visa status and any other information relevant to their ability to accept employment. Send letter of application with vita, graduate transcript or list of courses, and direct three letters of recommendation to:

Screening Committee
Department of Mathematics & Statistics
Murray State University
Murray, Ky. 42071

MSU is an EO/AA employer.

STANFORD UNIVERSITY Department of Mathematics and Statistics

We invite applications for a tenure-track position in probability at the Assistant Professor level beginning Autumn Quarter 1990 to 1991. The position is a joint appointment in the Department of Mathematics and Statistics. Excellent research potential in probability and stochastic processes, strong interests in applications, and commitment to quality teaching are required. Outstanding candidates at higher ranks will also be considered. Please submit applications, curriculum vitae and letters from three professional references to: Yitzhak Katznelson, Chairman of Search Committee, Department of Mathematics, Stanford University, Stanford, CA 94305-2125, U.S.A.

Stanford University is an Equal Opportunity, Affirmative Action Employer, and welcomes applications from women and minorities.

AMERICAN UNIVERSITY OF BEIRUT TEACHING OVERSEAS

The Department of Mathematics at the American University of Beirut in Beirut, Lebanon (AUB) invites applications for faculty positions at the level of Assistant Professor or above, available October 1, 1990. Candidates are sought in the fields of Analysis, Mathematical Statistics, and Topology.

Applicants should hold the Ph.D. degree and would be expected to teach undergraduate and graduate courses and to be committed to research. Post-doctoral experience is preferred.

Appointments are normally made for a three-year period. AUB is an EO/AA employer.

Interested persons may send their curriculum vitae and three letters of recommendation before March 31, 1990 to the Dean of Arts and Sciences, c/o New York Office of the American University of Beirut, 850 Third Avenue, New York, New York 10022, USA.

U.S. passports are presently invalid for travel to, in or through Lebanon, and for residence in Lebanon, by order of the Department of State, and therefore applications from individuals who would travel to or reside in Lebanon on a U.S. passport cannot at this time be considered.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY MATHEMATICAL PHYSICS

The Center for Transport Theory and Mathematical Physics at Virginia Tech anticipates a number of openings for visitors during academic year 1990-91. Applications in all areas of mathematical physics are invited for all or any parts of the year. There may also be possibilities of tenure-track appointments. Appointments may be made at any level, from postdoctoral up. Please send a curriculum vitae and a short description of research plans (for visiting positions only) and arrange for three letters of recommendation to be sent directly to Prof. P. F. Zweifel, Virginia Polytechnic Institute and State University, CTTMP-212A Robeson Hall, Blacksburg, VA 24061-0435, USA. VA Tech is an EO/AA employer. Women and minorities are encouraged to apply.

POSITIONS AVAILABLE

UNIVERSITY OF WYOMING Department of Mathematics

Invites applications for the following positions:

One tenure-track position at the assistant professor level in the area of functional analysis, numerical linear algebra, dynamical systems theory, and algebraic/computational combinatorics.

Send resume and direct three letters of recommendation to:

Professor W. Bridges, Chairman
Mathematics Department
P.O. Box 3036 University Station
University of Wyoming
Laramie, WY 82071-3036
(307) 766-4222

Applications completed by January 31, 1990 will be given first consideration. The University of Wyoming is an Equal Opportunity/Affirmative Action Employer.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY DEPARTMENT OF MATHEMATICS

We anticipate making several tenure-track appointments at the assistant professor level or above beginning with the academic year 1990-1991. Very strong research potential is required for junior-level appointments and a demonstrated outstanding record for senior-level appointments. A Ph.D. is required. Primary areas of interest are algebraic and differential geometry, discrete mathematics, dynamical systems, and computationally oriented mathematics. Exceptional candidates in other areas will be considered. Applications will be accepted until March 15, 1990, or until the positions are filled. Applicants should send vita and three letters of reference to: Chairman, Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24016-0123. Women and minorities are encouraged to apply. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

THE UNIVERSITY OF SCRANTON Mathematics Department

The University of Scranton is a Jesuit university with over 3,500 undergraduates. The Mathematics Department is newly formed from a split in a combined Mathematics/Computer Science Department. It has 15 full time faculty and about 50 majors.

Four tenure-track positions are available for Fall 1990 for faculty interested in a teaching environment where research is encouraged and supported. Individuals with expertise in any area of mathematics will be considered. Preferred areas include Applied Mathematics, Probability/Statistics, Actuarial Mathematics, Algebra, and Analysis. Rank and salary are open and competitive.

Submit a vita, transcripts, and three references to Mathematics Faculty Search Committee, University of Scranton, Scranton, PA, 18510 or phone (717) 961-7774. Screening will begin at once and applications will be considered until all positions have been filled. An AA/EO Employer and Educator.

UNIVERSITY OF NOTRE DAME DEPARTMENT OF MATHEMATICS NOTRE DAME, INDIANA 46556 ANDREW J. SOMMESE, CHAIRMAN

Several tenured or tenure-track positions. The Mathematics Department is eager to found a group in Applied Mathematics. Outstanding candidates in applied mathematics are encouraged to apply, particularly in dynamical systems/ordinary differential equations, numerical analysis, statistics/probability. Rank and salary depend on experience and qualifications. Applications should demonstrate accomplishment and potential in teaching and research, and should include vita, a few selected reprints or preprints, and 3 or 4 letters of recommendation. Notre Dame is an Equal Opportunity/Affirmative Action Employer. Women and minorities are particularly encouraged to apply.

JOHNS HOPKINS UNIVERSITY

The Mathematical Sciences Department invites applications for the 1990-91

ELIEZER NADDOR POSTDOCTORAL FELLOWSHIP.

The Fellow is to be an outstanding graduating doctoral student in mathematics, statistics, or operations research, who plans an academic research center. The fellowship provides a \$29,000 stipend plus fringe benefits, to fully support 12 months of postdoctoral study at the department in an area of interest to some department faculty member free from teaching and administrative duties. Selection is made without discrimination on the basis of race, color, religion, sex, or national origin. Applicants should provide current vita, a letter describing career aspirations and a research plan for the fellowship year, and transcripts, and should arrange for three letters of recommendation to be sent by February 28, 1990, to:

Professor John C. Wierman, Chairman
Mathematical Sciences Department
220 Maryland Hall
The Johns Hopkins University
Baltimore, Maryland 21218

EOE/AA

UNIVERSITY OF SOUTHERN COLORADO DEPARTMENT OF MATHEMATICS PUEBLO, CO 81001-4901

Applications are invited for several tenure-track assistant professor positions for Fall 1990. Doctorate in Mathematics required. Evidence of commitment to teaching excellence necessary. Active research desirable. Send letter of application, resume, graduate transcripts, and three letters of reference to Search and Screen Committee. Evaluation applications will begin 7 February 1990 and continue until positions are filled. USC is AA/EO employer.

PUBLICATIONS WANTED

CORNELL UNIVERSITY
Department of Mathematics

Wanted: Mathematical books, journals, reprints, ephemera. Contact R. K. Dennis, Math. Dept., White Hall, Cornell U., Ithaca, NY 14853-7901. Tel: 607-255-4027, FAX: 607-255-7149. e-mail: dennis@mssun7.msi.cornell.edu

AWARDS

UNIVERSITY OF MARYLAND
THE MONROE MARTIN PRIZE IN
APPLIED MATHEMATICS

THE INSTITUTE FOR PHYSICAL SCIENCE AND TECHNOLOGY at the UNIVERSITY OF MARYLAND, College Park is pleased to announce the fourth MONROE MARTIN PRIZE for an OUTSTANDING PAPER OR CONTRIBUTION IN APPLIED MATHEMATICS (including numerical analysis) by a young research worker. Candidates must be residents of North America and not more than 35 years of age at the filing deadline. Submitted papers must be by a single author and have been published, or accepted for publication, in the open literature subsequent to January 31, 1985. The work must not have been performed in connection with the completion of requirements for an academic degree.

Applications from qualified candidates, or nominations, are solicited for the Monroe Martin prize. Entries should include a copy of the paper or contribution, with a covering letter, and be submitted on or before July 31, 1990, to

J. A. Yorke, DIRECTOR
INSTITUTE FOR PHYSICAL SCIENCE
AND
TECHNOLOGY
UNIVERSITY OF MARYLAND
COLLEGE PARK, MARYLAND 20742

The award will be announced by November 1, 1990. The recipient will be asked to present his or her work at the Monroe Martin Lecture at the University of Maryland in December, 1990, and will be awarded a prize of \$1000 plus travel expenses.

The Monroe Martin prize was established to commemorate the achievements of Professor Monroe Martin, former Director of the Institute for Fluid Dynamics and Applied Mathematics, and Chair of the Mathematics Department at the University of Maryland. Previous prize winners are Neil Berger, Marshall Slemrod, and Jonathan Goodman.

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ARIZONA STATE UNIVERSITY

Department of Mathematics

The Department of Mathematics invites applications for tenure-track and visiting faculty positions at all ranks and in all areas of mathematics beginning in August 1990. The Department is in the third year of a major development program intended to build nationally recognized research groups of four to seven faculty members in Computational Mathematics, Differential Equations (including PDE's), Discrete Mathematics, Dynamical Systems, Operator Theory, Algebraic Geometry and Number Theory, Systems and Control and Probability and Statistics. During the past two years, 12 tenure-track or tenured appointments have been made and we anticipate making at least 5 appointments during each of the next three academic years.

For 1990, the majority of the tenure-track appointments will be made at the Assistant Professor level. To be considered for such an appointment, the candidate must demonstrate potential for outstanding research while providing effective teaching at both the undergraduate and graduate levels in a public university environment. For candidates at the Associate Professor level, additional requirements include a proven record of outstanding research accomplishments and versatile and effective teaching. At the Full Professor level, applicants should be recognized nationally for the quality and scope of their research and leadership activities. Salaries are competitive and commensurate with experience and qualifications.

In support of its research and graduate education programs, the Department has installed an Advanced Computing Facility centered around a network of Titan Mini-Super Graphics computers plus a cluster of Work Stations. Research efforts were enhanced by direct access to the University's CRAY XMP-14/se and IBM 3090-500E/VF super computers.

Arizona State University has more than 43,000 students and is located in the rapidly growing Phoenix Metropolitan area—a center of business, finance and high technology. The valley offers a wide range of educational, cultural and recreational opportunities. Pleasant and convenient housing is widely available near the university campus.

Applications should be received by December 1, 1989, and the Department will begin to review applications as of this date. The deadline will be extended on a month-to-month basis until all available positions are filled.

Applicants should send their resumés and arrange for at least three letters of recommendation to be sent to: William T. Trotter, Chair, Department of Mathematics, Arizona State University, Tempe, AZ 85287-1804. AA/EOE

ARIZONA STATE UNIVERSITY



MATHEMATICAL REVIEWS

ASSOCIATE EDITOR

Applications and recommendations are invited for a two-year appointment as an Associate Editor of *Mathematical Reviews* (MR), to commence no later than the summer of 1990. Applications will be welcomed from persons taking leave from other positions, and in particular from tenured faculty members who can take leave to come to MR for two years.

The MR office of the American Mathematical Society is located in Ann Arbor, Michigan, not far from the campus of the University of Michigan, and the editors (although employees of the AMS) enjoy many privileges at the university. At present MR employs fourteen mathematical editors, about ten consultants, and over sixty nonmathematicians. It produces *Mathematical Reviews*, *Current Mathematical Publications*, various indexes, the online service MathSci, and MathSci Disc. The responsibilities of an Associate Editor fall primarily in the day-to-day operations of selecting articles and books suitable for review, classifying these items, assigning them to reviewers, editing the reviews when they are returned, and correcting galley proof. At this time an individual with considerable breadth in applied mathematics is sought (such as in differential equations, optimization, operations research, systems theory, control theory, information theory, etc.). The ability to write good English is essential, and the ability to read mathematics in major foreign languages is important. (The ability to read mathematical articles in Russian or Chinese is especially desirable.)

Persons interested in combining a sabbatical or other leave with a part-time appointment as an Associate Editor should write (or telephone) for further details. The twelve-month salary is negotiable, and will be commensurate with the experience the applicant brings to the position. Salary and fringe benefits are similar to those in universities. Of special importance is a policy providing termination pay of three months full pay for an editor serving full time for two years.

Applications (including curriculum vitae, bibliography, and names and addresses of at least three references) and recommendations should be sent to Dr. R. G. Bartle, Executive Editor, *Mathematical Reviews*, P. O. Box 8604, Ann Arbor, MI 48107-8604. (Telephone: 313-996-5255; FAX: 313-996-2916; INTERNET: RGB@MATH.AMS.COM.) Persons who may be interested in applying for this position are urged to inquire without delay.

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MATHEMATICAL REVIEWS EXECUTIVE EDITOR

Applications and nominations are invited for the position of Executive Editor of Mathematical Reviews (MR).

The Executive Editor is the chief executive officer at MR and is responsible for all phases of its operations. These duties include:

- **direction of the editorial and consulting staff and the administration of the non-editorial staff**
- **relations with reviewers and authors**
- **maintaining scientific and editorial standards**
- **budget planning and control**

The Executive Editor is assisted in administration by an Associate Executive Editor and a Managing Editor; the Executive Editor reports to the Executive Director of the American Mathematical Society. The MR Editorial Committee provides Society overview and support in maintaining the scientific and editorial standards of MR.

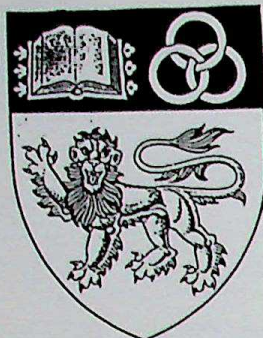
The MR editorial office is located in Ann Arbor, Michigan, near the campus of the University of Michigan, and the editors enjoy many faculty privileges at the University. MR employs eleven associate editors, several consultants, and over sixty-five other full-time personnel. It publishes *Mathematical Reviews*, *Current Mathematical Publications*, special *Review* volumes and various *Indexes*. The major activity is the creation and maintenance of the MR database from which these publications and the online and CD-ROM service, MathSci, are produced.

The appointment will be for a negotiable period of from two to five years and should commence by September 1, 1990. The appointment has the possibility of renewal. Applications are welcomed from individuals taking leaves of absence from other positions; however, the Executive Editor position is full-time. Salary is negotiable and will be commensurate with experience. Generous benefits are available including study leave.

Nominations and applications (including curriculum vitae, bibliography, data on experience and names and addresses of at least three references) should be sent on or before **March 1, 1990** to:

Dr. William Jaco, Executive Director
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

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NATIONAL UNIVERSITY OF SINGAPORE

DEPARTMENT OF MATHEMATICS

Applications are invited for teaching appointments from candidates who are able to teach in one or more of the following areas:

Pure Mathematics
Applied Mathematics
Operational Research
Statistics

Candidates should possess a PhD degree in Mathematics or its equivalent.

Gross annual emoluments range as follows:

Lecturer	S\$50,390 - 64,200
Senior Lecturer	S\$58,680 - 100,310
Associate Professor	S\$88,650 - 122,870

(US \$1.00 = S\$1.96 approximately)

The commencing salary will depend on the candidate's qualifications, experience, and the level of appointment offered.

Leave and medical benefits will be provided. Depending on the type of contract offered, other benefits may include: provident fund benefits or an end-of-contract gratuity, a settling-in allowance of S\$1,000 or S\$2,000, subsidised housing at nominal rentals ranging from S\$100 to S\$216 p.m., education allowance for up to three children subject to a maximum of S\$10,000 per annum per child, passage assistance and baggage allowance for the transportation of personal effects to Singapore. Staff members may undertake consultation work, subject to the approval of the University, and retain consultation fees up to a maximum of 60% of their gross annual emoluments in a calendar year.

The Department of Mathematics is a department in the Faculty of Science. There are 8 faculties in the National University of Singapore with a current student enrolment of some 14,000. All departments are well-equipped with a wide range of facilities for teaching and research.

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Application forms and further information on terms and conditions of service may be obtained from:

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Enquiries may also be sent through BITNET to: **PERSDEPT @ NUSVM**, or through **Telefax: (65) 7789948**



Sandia National Laboratories

THEORETICAL COMPUTER SCIENCE RESEARCH FELLOWSHIP

Mathematical and Computational Science
Department

Sandia National Laboratories is seeking outstanding candidates in the area of theoretical computer science to fill its 1990 Research Fellowship in Computational Science. The Fellowship is intended to provide an exceptional research opportunity for new graduates in theoretical computer science. Sandia is primarily interested in the areas of computational geometry and parallel computation, but other specialties will be considered as well. Sandia provides an excellent environment for research in theoretical computer science. Our strong applied research programs in robotics, parallel computing, and cryptography create a wealth of new problems in computational geometry, parallel computation, and computational number theory. In addition, several leading-edge massively parallel computers are available in the department.

The fellowship appointment is for a period of one year and may be renewed for a second year. It includes a highly competitive salary, moving expenses, and a generous professional travel allowance. The successful candidate must be a U.S. citizen, must have earned a Ph.D. degree or the equivalent, and should have a strong background in theoretical computer science or discrete mathematics. Applications from qualified candidates, as well as nominations for the Fellowship, should be addressed to **Robert H. Banks, Division 3531-23B, Sandia National Laboratories, PO Box 5800, Albuquerque, NM 87185**. Applications should include a resume, a statement of research goals, and the names of three references. The closing date for applications is April 30, 1990. The position will commence during 1990. Further inquiries can be made by calling (505) 846-7564 or by sending Email to EFBRICK@SANDIA.GOV.

Sandia National Laboratories is pleased to announce that the 1989 Sandia Research Fellowship in Computational Science has been awarded to Dr. Steven J. Plimpton of Cornell University to carry out research in parallel methods for the atomistic simulation of solids.

APPLIED MATHEMATICAL SCIENCES RESEARCH FELLOWSHIP

Mathematics and Computational Science
Department

Sandia National Laboratories is seeking outstanding candidates in the areas of numerical mathematics or symbolic computing to fill its 1990 Applied Mathematical Sciences Research Fellowship. The Fellowship is supported by a special grant from the Applied Mathematical Sciences Research Program at the U.S. Department of Energy.

The Fellowship is intended to provide an exceptional opportunity for young researchers. Sandia's Mathematics and Computational Science Department maintains strong research programs in theoretical computer science, analytical and computational mathematics, computational physics and engineering, advanced computational approaches for parallel computers, graphics, and architectures and languages. Sandia provides a unique parallel computing environment, including a 1024-processor NCUBE 3200 hypercube, a 1024-processor NCUBE 6400 hypercube, a Connection Machine-2 and several large Cray supercomputers. The successful candidate must be a U.S. citizen, must have earned a Ph.D. degree or the equivalent, and should have a strong interest in advanced computing research.

The fellowship appointment is for a period of one year, and may be renewed for a second year. It includes a highly competitive salary, moving expenses, and a generous professional travel allowance. Applications from qualified candidates, as well as nominations for the Fellowship, should be addressed to **Robert H. Banks, Division 3531-24B, Sandia National Laboratories, PO Box 5800, Albuquerque, NM 87185**. Applications should include a resume, a statement of research goals, and the names of three references. The closing date for applications is April 30, 1990. The position will commence during 1990. Further inquiries can be made by calling (505) 844-2248 or by sending Email to RCALLEN@SANDIA.GOV.

Sandia National Laboratories is pleased to announce that the 1989 DOE Applied Mathematical Sciences Research Fellowship has been awarded to Dr. Raymond G. Tuminaro of Stanford University to continue his research in advanced iterative algorithms for parallel computation.

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For further information please contact: Ms. Helen F. Pirrello, Rutgers University, Dept. of Mathematics, Hill Center-Busch Campus, N.B., NJ 08903 Tele. (201) 932-3921 Fax (201) 932-5530, e-mail pirrello@math.rutgers.edu

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International Journal of Mathematics will publish original papers in mathematics in general, but giving a preference to those in the areas of mathematics represented by the editorial board. The journal will be published quarterly, or more frequently whenever necessary, to bring out new results without delay. Occasionally, expository papers of exceptional value may be also published.

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2. Curriculum vitae and a list of publications.
3. Three (3) letters of recommendations, to be sent directly to the AHPRC.

SENIOR MEMBERSHIPS are available. Preference will be given to supplementary support for those with sabbaticals, fellowships, or other stipends.

All materials should be submitted by February 16, 1990. All correspondence should be directed to:

University of Minnesota
Army High Performance Computing Research Center
Visiting Memberships
6-196 EE/CS Building
200 Union Street S.E.
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Professor A. Duane Porter - Mathematics Department
Box 3036 - University of Wyoming
Laramie, Wyoming 82071

WEAK CONVERGENCE METHODS FOR NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS

Lawrence C. Evans

(CBMS Regional Conference Series, Number 74 • Supported by the National Science Foundation)

The purpose of this book is to explain systematically and clearly many of the most important techniques set forth in recent years for using weak convergence methods to study nonlinear partial differential equations. This work represents an expanded version of a series of ten talks presented by the author at Loyola University of Chicago in the summer of 1988.

The author surveys a wide collection of techniques for showing the existence of solutions to various nonlinear partial differential equations, especially when strong analytic estimates are unavailable. The overall guiding viewpoint is that when a sequence of approximate solutions converges only weakly, one must exploit the nonlinear structure of the PDE to justify passing to limits. The author concentrates on several areas that are rapidly developing and points to some underlying viewpoints common to them all. Among the several themes in the book are the primary role of measure theory and real analysis (as opposed to functional analysis) and the continual use in diverse settings of low amplitude, high frequency periodic test functions to extract useful information. The author uses the simplest problems possible to illustrate various key techniques.

Aimed at research mathematicians in the field of nonlinear PDEs, this book should prove an important resource for understanding the techniques being used at the forefront of this vital area of research.

1980 *Mathematics Subject Classifications*: 35, 46

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- 03 Mathematical logic and foundations
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- 08 General mathematical systems
- 11 Number theory
- 12 Field theory and polynomials
- 13 Commutative rings and algebras
- 14 Algebraic geometry
- 15 Linear and multilinear algebra; matrix theory
- 16 Associative rings and algebras
- 17 Nonassociative rings and algebras
- 18 Category theory, homological algebra
- 19 K-theory
- 20 Group theory and generalizations
- 22 Topological groups, Lie groups
- 26 Real functions
- 28 Measure and integration
- 30 Functions of a complex variable
- 31 Potential theory
- 32 Several complex variables and analytic spaces
- 33 Special functions
- 34 Ordinary differential equations
- 35 Partial differential equations
- 39 Finite differences and functional equations
- 40 Sequences, series, summability
- 41 Approximations and expansions
- 42 Fourier analysis
- 43 Abstract harmonic analysis
- 44 Integral transforms, operational calculus
- 45 Integral equations
- 46 Functional analysis
- 47 Operator theory
- 49 Calculus of variations and optimal control; optimization
- 51 Geometry
- 52 Convex sets and related geometric topics
- 53 Differential geometry
- 54 General topology
- 55 Algebraic topology
- 57 Manifolds and cell complexes
- 58 Global analysis, analysis on manifolds
- 60 Probability theory and stochastic processes
- 62 Statistics
- 65 Numerical analysis
- 68 Computer science
- 70 Mechanics of particles and systems
- 73 Mechanics of solids
- 76 Fluid mechanics
- 78 Optics, electromagnetic theory
- 80 Classical thermodynamics, heat transfer
- 81 Quantum mechanics
- 82 Statistical physics, structure of matter
- 83 Relativity
- 85 Astronomy and astrophysics
- 86 Geophysics
- 90 Economics, operations research, programming, games
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- 93 Systems theory; control
- 94 Information and communication, circuits

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Minimum dues for **contributing members** are \$138.

For either **students** or **unemployed individuals**, dues are \$23, and annual verification is required.

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I am a full-time student at
 currently working toward a degree.

2 Unemployed Verification (sign below) I am currently unemployed and actively seeking employment. My unemployment status is not a result of voluntary resignation or of retirement from my last position.

3 Reciprocity Membership Verification (sign below) I am currently a member of the society indicated on the right and am therefore eligible for reciprocity membership.

Reciprocating Societies

- ☐ Allahabad Mathematical Society
- ☐ Asociación Matemática Española
- ☐ Australian Mathematical Society
- ☐ Berliner Mathematische Gesellschaft e.V.
- ☐ Calcutta Mathematical Society
- ☐ Dansk Matematisk Forening
- ☐ Deutsche Mathematiker-Vereinigung e.V.
- ☐ Edinburgh Mathematical Society
- ☐ Gesellschaft für Angewandte Mathematik und Mechanik
- ☐ Glasgow Mathematical Association
- ☐ Indian Mathematical Society
- ☐ Iranian Mathematical Society
- ☐ Irish Mathematical Society
- ☐ Íslenska Staerðfræðafélagið
- ☐ Israel Mathematical Union
- ☐ János Bolyai Mathematical Society
- ☐ Korean Mathematical Society
- ☐ London Mathematical Society
- ☐ Malaysian Mathematical Society
- ☐ Mathematical Society of Japan
- ☐ Mathematical Society of the Philippines
- ☐ Mathematical Society of the Republic of China
- ☐ New Zealand Mathematical Society
- ☐ Nigerian Mathematical Society
- ☐ Norsk Matematisk Forening
- ☐ Österreichische Mathematische Gesellschaft
- ☐ Polskie Towarzystwo Matematyczne
- ☐ Punjab Mathematical Society
- ☐ Ramanujan Mathematical Society
- ☐ Real Sociedad Matemática Española
- ☐ Sociedad Colombiana de Matemática
- ☐ Sociedad de Matemática de Chile
- ☐ Sociedad Matemática de la Republica Dominicana
- ☐ Sociedad Matemática Mexicana
- ☐ Sociedade Brasileira Matemática
- ☐ Sociedade Brasileira de Matemática Aplicada e Computacional
- ☐ Sociedade Paranaense de Matemática
- ☐ Sociedade Portuguesa de Matemática
- ☐ Societat Catalana de Matemàtiques
- ☐ Société de Mathématiques Appliquées et Industrielles
- ☐ Société Mathématique de Belgique
- ☐ Société Mathématique de France
- ☐ Société Mathématique Suisse
- ☐ Southeast Asian Mathematical Society
- ☐ Suomen Matemaattinen Yhdistys
- ☐ Svenska Matematikersamfundet
- ☐ Union Matemática Argentina
- ☐ Unione Matematica Italiana
- ☐ Vijnana Parishad of India
- ☐ Wiskundig Genootschap

Letters to the Editor

Boycotting Scientific Visits to China

The undersigned are among those who have had the happy experience of visiting China for mathematical reasons in the past decade. We are saddened by the massacre of June 4, 1989, in Beijing and wish to share our sentiments in this matter with our colleagues.

As scientific visitors we admire the new China and feel fortunate that we could contribute in a very small way to its progress towards modernization. We are, however, appalled by the brutal suppression of peaceful demonstrations of the students and citizens and by the dishonesty of the official government explanation of what happened. Inasmuch as further visits to China might be interpreted as endorsing the course of action of the present government, we shall refrain from such visits until the hunting down of dissident students and the gagging of their free speech cease.

We continue to be willing and eager to help our Chinese colleagues in every other way.

William B. Arveson

Michael F. Atiyah

Hyman Bass

(Received October 10, 1989)

[Note]: This letter was signed jointly by 52 mathematicians of which the above are the first three in alphabetical order. The complete list of all 52 signatories appears on page 362.

**A Differing View on
Mathematics Education Reform**
Teaching high school mathematics must be frustrating! The subject seems to be disliked by students and parents. All seem to find mathemat-

ics difficult and question its value for them. Parents recall their own experiences and readily make excuses for the lack of interest and success of their offspring in mathematics. Government and industry cry for better mathematics education following each report which compares American students' performance in mathematics to that of their foreign counterparts. And the final blow must be the suggestion by the mathematics establishment that the problem lies in what and how mathematics is being taught. That comes very close to saying the problem lies with the teachers! Although that is not the intent of recent calls for reform, I suspect that is at the heart of the recent article "A Differing View on Mathematics Education Reform" by E. G. Palais which appeared in *Notices* (November 1989, p. 1189).

Her article begins by linking current plans for reform to the "New Math". And while we would all like to forget the experience of the mathematics community with "New Math", we can't. But current efforts are truly different. No curricular changes are being imposed from the top, and practicing school teachers are providing much of the impetus and leadership for the proposed reforms.

But let us talk about change itself! First, it has been over a decade since real serious thought was given to the contents of the school mathematics curriculum except on an ad hoc basis. But both mathematics and the mathematical needs of society have changed more in this decade than in the previous century. The now ubiquitous computer has seen to that. Moreover, we are not talking about starting over, and people are looking at what works and what doesn't. Unfortunately, much doesn't work.

Further, although we are somewhat reluctant to admit it, kids are different. While the wistful comment that the real problem is getting students to work may have some va-

lidity, it is analogous to stating that the problem with night is that the sun doesn't shine. In both instances, useful illumination must be achieved some other way. And proposed reforms make clear and underline the need to make mathematics more than a spectator sport. The real issue is can we do better, and many people believe we can. Would it help if students worked harder and were better prepared. Certainly! But that will be true with an old curriculum or a new curriculum. Can we offer a better mathematics education to those who do study mathematics? Can we get more students interested in mathematics, students who will stay with the sciences and mathematics, students who will go on to be engineers, biologists, economists as well as physicists, chemists or mathemati-

Policy on Letters to the Editor

Letters submitted for publication in *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule normally requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of *Notices* in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in *Bulletin of the American Mathematical Society* will be considered for publication. All published letters must include the name of the author.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, and will be acknowledged on receipt.

cians? Can we equip students with the increased mathematics necessary for the current job market?

These are the questions and hopefully all of us can work together to answer them in the affirmative. It will not be easy but the stakes are high and the time is right!

Ronald G. Douglas
State University of New York
at Stony Brook

(Received December 15, 1989)

Revamping and Revitalizing

Abstracts

I would like to propose that the *Abstracts of the AMS* be revamped and revitalized. As it is now, the *Abstracts* serves the function of informing the readers of the contents of talks given at AMS meetings, but the "Abstracts presented by title" section strikes me as totally worthless. It seems that the overwhelming majority of the membership is deliberately boycotting this section, as if it were well known that only "losers" publish there—which soon becomes a self-fulfilling prophecy.

This is really a shame, because I think there is a genuine need for a good early notice medium, and the *Abstracts* could fill this need. I would guess that the average waiting time between submission and publication of an article is at least two years, and there is no sign of this decreasing in the future. But a lot happens during this waiting period. The author is likely to get a lot of useful feedback from those who read the paper in preprint form, often leading to improvements in the published version, and the readers in turn benefit by being able to develop and extend the results of the paper in their own work. But the delivery system for preprints is hit-and-miss at best, and discriminatory at worst. The goal of a good *Abstracts* should be to make preprints available to everyone who is interested.

To this end, I would like to see an expanded *Abstracts*, with many more entries and more space for

each entry. I would also like to see the style of entries changed. Perhaps the term "abstract" should be replaced by "preview," or something else (in some sense they are really advertisements). The preview should be written to stimulate the interest of the reader and attract an audience for the paper. Precise statements of results (incomprehensibly condensed) would not be required, or necessarily encouraged. Some sort of editing and refereeing will undoubtedly be needed, but a publication of a preview should not have to mean that someone vouches for the correctness of the paper—only that it appears to be of interest to a reasonably sized audience. I would hope that an author of a preview would be required to simultaneously submit the preprint, and agree to send it to everyone who requests it.

This proposal makes demands on time and money from the Society. Would it be worth the cost and effort? This is a question the membership should consider. I would say, however, that one more ingredient is needed for this project to succeed: the participation of mathematical authors. Sending previews to the new *Abstracts* has to be a desirable activity for all mathematicians, not just the desperate or the down-and-out. One way to encourage this would be to make the publication of research announcements in the *Bulletin* conditional on an invitation from an editorial committee that selects from submissions to the *Abstracts*.

Robert S. Strichartz
Cornell University

(Received December 26, 1989)

The Boeing Lecture Series in the Mathematical Sciences

We would like to share the development of a successful cooperative program between industry and our department. We hope that other mathematics departments will find our example useful in developing similar programs which gain local industrial support.

In 1987 the Department of Mathematics and Statistics at The Wichita State University approached Boeing Military Airplanes, a company with a local presence, with a proposal to develop a lecture series. The lecture series would bring well-known mathematicians to The Wichita State University to make presentations on selected topics in the mathematical sciences.

A partnership between Boeing Military Airplanes and the Mathematics and Statistics Department at The Wichita State University was established for the purpose of developing the lecture series. Our department agreed to serve as host and to be responsible for presenting the lecture series. In return, Boeing agreed to sponsor the series.

Each partner has enjoyed numerous benefits from the lectures presented in the series. For example, Boeing personnel have found fresh approaches and new insights into technical problems encountered in their work and our faculty members have likewise gained insight into current research areas.

In the first two years of the lecture series, we have been visited by twenty-four noted researchers in the mathematical sciences who represent universities in thirteen states (from coast to coast) and seven foreign countries. As a consequence, The Wichita State University mathematics faculty has become much more widely known. This has contributed to the recognition of our Ph.D. program. Likewise, Boeing Military Airplanes benefits from the broad exposure of the Boeing Lecture Series to the academic world.

Whereas additional public funding for a lecture series would be difficult for us to obtain, Boeing would have an equally difficult time making the arrangements for lectures and talk to their workforce. This is one example of the symbiotic relationship established by the series in which both partners received benefits far greater than their individual

contributions.

Cooperative efforts, such as the lecture series, abound with industry and departments of engineering. We believe it is noteworthy that this endeavor involves industry and the Department of Mathematics and Statistics. In fact, we have not been able to identify a similar relationship between industry and a department of mathematics at any other university in the United States.

The opportunity must exist for other departments of mathematics to establish similar partnerships with industry. How does a department solicit financial assistance from business or industry to sponsor such a program? We feel we were successful because we neither went hat-in-hand begging for money, nor did we demand support. Rather, we presented a list of outcomes whose benefits far outweighed the investment. In this way, the company could see exactly what their financial support was buying and make their decision based upon the return on their investment. We like this approach because we feel that mathematics, as the engine which drives the technological development in engineering and related disciplines, offers the greatest return for each dollar invested.

Gary D. Crown
The Wichita State University
(Received November 13, 1989)

Advertisements for Positions

Applicants for positions advertised in *Notices* should be aware that in reality things may not be as stated in the advertisement.

I responded to an advertisement placed by Florida Atlantic University in the November 1989 issue of *Notices* (Vol. 35, No. 9, p. 1429) inviting

applications for a senior level tenured appointment in the Department of Mathematics. I would not have applied if the advertisement had said tenure track rather than tenured. I was fortunate to be offered the position. However, the offer was made without tenure and upon inquiry the Provost of the university wrote "The awarding of tenure upon hiring is something that has not been done here even for holders of our endowed and eminent scholar chairs".

The university explicitly advertised a tenured position knowing that in reality it was only tenure track.

Kenneth S. Williams
Carleton University
(Received October 24, 1989)

Addition versus Replacement

Sandra Harding in her letter (December 1989 *Notices*) quotes Stephen Jay Gould, "Science advances primarily by replacement not by addition." We should, however, be reminded that mathematics advances primarily by addition not by replacement.

John Mitchem
San Jose State University
(Received January 11, 1990)

Author's Note

A reader of my article "Feminist Critiques of Science," which appeared in the July/August 1989 issue of *Notices*, has called to my attention a problem with a statement I made. In the article, I said that the Benbow-Stanley study has been "debunked by many critics." The study found that boys predominate among the high scorers when mathematically talented youngsters take the mathematics portion of the Scholastic Aptitude Test.

My use of the term "debunked" was ill-advised and rather careless. I have not seen studies that have debunked Benbow-Stanley in the sense of finding actual errors or falsehoods in that study. I should have said that many have been critical of the study and the conclusions inferred from it. In addition, a good deal of the negative reaction to Benbow-Stanley seems actually to have stemmed from media accounts which exaggerated and distorted the conclusions of the study—accounts that Benbow and Stanley themselves say they regret. The original study, "Sex Differences in Mathematical Reasoning Ability: Fact or Artifact?" (*Science*, 12 December 1980, volume 210, pages 1262-1264), as well as other writings by these researchers, are generally circumspect and careful in their explanations of the boys' superior achievement on the SAT.

Whether or not their explanations are correct is a different matter, and one which I do not feel qualified to judge without further study of the literature. It is clear, though, that the Benbow-Stanley hypothesis of "superior male mathematical ability" is far from unanimously accepted. For interested readers, a good source of information on both sides of the controversy is *Behavioral and Brain Research*, June 1988, Volume 11, Number 2, pages 169-232, which contains a survey article by Camilla Benbow together with critical commentary by more than 40 other researchers in various fields. The article includes an extensive bibliography of much of the literature on this topic.

Allyn Jackson
Staff Writer

Graduate Education in Mathematics

Is it Working?

Graduate education in mathematics has remained relatively unscathed as the critiques fly back and forth in the current debate on mathematics education reform. But, judging by some of the discussions at the Joint Mathematics Meetings in Louisville in January, this preferred treatment isn't likely to continue. During the Meetings, there were rumblings that perhaps all is not well in doctoral training in mathematics. Some of the problems most frequently cited are too much specialization, too little emphasis on quality teaching, a lack of experience with collaborative research and computation, and an environment that does little to encourage women and underrepresented minorities to enter the field.

Traditional Training

Ivar Stakgold, president of the Society for Industrial and Applied Mathematics and professor at the University of Delaware, was a speaker at a panel discussion on graduate education at the Louisville meeting. He acknowledged that the present doctoral training system has produced a remarkably strong research establishment, "but at what cost?" he asked. "I don't mean financial cost. I mean the cost of unfulfilled obligations and the cost of missed opportunities. There is in my view a very serious mismatch between what graduate education is in mathematics and what the employment needs are."

Graduate students are still trained in the traditional manner with a heavy emphasis on research, Stakgold noted, despite the fact that most new Ph.D.s will end up with positions at institutions where teaching, not research, is the principal duty. As for industrial positions, he asserted that the standard beginning graduate courses "do not provide the intellectual, philosophical, and historical overview" of mathematics that is necessary to develop the skills required in most industrial positions.

Most agree that teaching skills are lacking in Ph.D. training, but some also question the effectiveness of research training. During the panel discussion, Judith S. Sunley, director of the Division of Mathematical Sciences at the National Science Foundation, remarked, "I think mathematicians, more than any other scientific

discipline, have a situation where only a very small percentage of the population ever does any research beyond their Ph.D. It's not clear to me that we're even doing good graduate education to enable people to do mathematics research, much less teaching."

Stakgold went on to offer a number of suggestions for change, such as a balance between group and individual activities (through problem seminars, for example), a component on computation, seminars built around modern mathematical themes to draw connections between different areas, and special programs for those seeking industrial positions. But given the amount of material that graduate students are already expected to master and the ever-lengthening average time to finish the doctorate, is it feasible to require yet more of students? Stakgold suggested that perhaps there could be two tracks to the Ph.D., one for research, and a second that would not necessarily include original research but would produce a scholar with broad mathematical training and skills.

Stakgold said he was not recommending reviving the "doctor of arts" degree of the 1960s, which was created at a time when many feared a shortage of mathematicians to fill faculty vacancies. Because the degree permitted critical, historical, or expository theses in lieu of a traditional research dissertation, it was thought that D.A. students would be able to finish more quickly, thus alleviating the projected faculty shortage. The idea never really caught on, though, and faculty vacancies were quickly filled as the number of mathematics doctorates rose rapidly in the early 1970s. (Some schools still offer the D.A. degree—they are listed periodically in *Notices*.)

Stakgold says he believes current production of traditional, research-oriented doctorates is sufficient. During the Meetings, others echoed this view, including an audience member at another session, who said he witnessed the disastrous job market of the early 1970s. At that time, around one-third more Ph.D.s were produced than now, and many went without jobs. Kenneth Hoffman, executive director of the Mathematical Sciences Education Board of the National Research Council, offered another view, saying that the present

was not "overproduction," but "under-utilization." He contrasted the situation in mathematics with that in English, another discipline that produced large numbers of Ph.D.s in the early 1970s. That community saw to it that English departments reduced class sizes and increased the number of faculty, thereby absorbing the large number of new doctorates. By contrast, he said, the mathematical community remained silent as class sizes ballooned and graduate students and part-time faculty were hired to teach. The situation of the 1970s notwithstanding, many projections of faculty supply into the year 2000 indicate that there will be serious shortfalls in the number of mathematicians available to fill retirement vacancies.

More Emphasis on Teaching

Whether the future job market turns out to be good or bad, the fact remains that most academic mathematics positions will emphasize teaching, a skill which is not developed in most graduate programs. During the panel discussion, Stephen B. Rodi of Austin Community College in Texas said he thought the entire mode of instruction in graduate school is "antithetical to the development of undergraduate teaching skills." He says that, by emphasizing "research *über alles*," graduate training develops and promotes a culture which is antagonistic to undergraduate instruction. Some of the specific problems he cited were overspecialization, too much abstraction and generalization, undue emphasis on formality, too much isolation, and too little connection with the important motivations to be found in applied mathematics.

In addition, Rodi spoke of the intensely competitive atmosphere of graduate school. "The student learns it is important who gets the proof first," he asserted. "It is important not only to be error-free but also to root out error in the work of others. All of this creates a future teacher both unreceptive toward and unskilled in the techniques of cooperative learning." Panelist William P. Thurston of Princeton University echoed this view, saying that many students feel their "license to ask stupid questions has been revoked" once they complete the Ph.D.

Despite these problems, Rodi sees some hope on the horizon. "I think it's interesting that over the last few years, there's been a whole lot more interest among prominent mathematicians in issues related to teaching," he said. But he maintained there must be changes in the culture of the community to place good teaching on a par with research. "An isolated course in teaching is not going to do much good," he said. Part of what is needed is for mathematics faculty to take their own teaching more seriously, so that they function as role models for good teaching.

Developing the Students

Many mathematicians see a decline in the quality of American graduate students over the last ten years or so; some say departments have been reluctant in recent years to hire new Ph.D.s in tenure-track positions in part because today's new doctorates are simply not as impressive as in past years. In many departments, the top students are foreigners, who now receive more than half the mathematics doctorates in this country. Weaknesses in the American educational system are partly responsible, but some say the real reason is that the brightest students are going into other fields. Some mathematics departments find that many of their majors are students who could not meet the grade-point-average requirements of computer science or engineering majors. "We get the bottom of the barrel," said one mathematician from a major research institution.

In addition, many see problems with the environment of graduate school. "We tend to forget that life as a graduate student is basically hell," says Lawrence Corwin of Rutgers University. Not only is the material difficult, he notes, but there are rituals analogous to hazing, like the qualifying examination, that add to the strain. "We give the students a bunch of material, and if they can do it, fine, if not, we forget them," he declared. D. J. Lewis of the University of Michigan also says the "sink or swim" attitude should change: "That's okay to produce an elite group, but not for the large numbers of doctorates we need to staff industry and colleges."

Corwin says mathematicians often assume that mathematics will be the obvious choice for the top students, but in fact professors must seek these students out and encourage them. "You have to spend time looking for them," he pointed out. "They may be considering engineering or physics or biology or business, so they need to be convinced to go into mathematics." Lewis says that mathematicians also need to inject an "aspect of discovery" into undergraduate courses from the beginning. Right now, he says, "our beginning courses are like sausage stuffing. They turn students off before the students discover the excitement of mathematics." He noted that, in trying to meet demands from other departments that require mathematics courses, "we've stopped teaching mathematics for mathematics' sake. We've shortchanged the engineer as much as the mathematician."

Postdoctoral Training

The problems associated with graduate training extend to the postdoctoral level as well, an issue discussed at the AMS Council meeting in Louisville. One difficulty is the terminology: generally, in mathematics, the word "postdoc" refers to a position or a fellowship that carries certain prestige or that is conferred as a distinction to

the top students. Sometimes the positions have reduced teaching loads, sometimes they involve only research. In other scientific disciplines, postdocs are more widely available, and are considered simply as the next step in training, rather than a special distinction. But today, as more fresh Ph.D.s are hired in temporary, rather than tenure-track, positions, more positions are being called postdocs.

"We label almost anything in the first two years as a postdoc," noted Ronald G. Douglas of the State University of New York at Stony Brook, but a postdoc should carry with it more training and mentoring, he said. Although those who get postdocs are usually those who became mature mathematicians in graduate school, he said, "others could become better mathematicians with a few years' more training." David Saltman of the University of Texas at Austin agreed, noting that students can spend twenty hours a week teaching while they're in graduate school and may need some uninterrupted research time afterward to develop into mature mathematicians.

One of the problems with most temporary positions for new Ph.D.s is that there often is little or no mentoring involved. Because of grant-seeking and other pressures on faculty, "we've come to a point where our habits make us waste graduate student talent," Douglas asserted. The first years of graduate school are a "Darwinian struggle," he said, and even after receiving their doctorates, young people often receive little encouragement and support. "No one ever takes them by the hand," said Thurston. But he also cautioned that increasing the number of postdocs might not have the intended effect unless faculty attitudes changed.

Some see increasing the number of postdocs as a way to encourage more people to enter the field. However, others expressed caution about increasing the numbers of doctorates, saying that more evidence was needed to show that there are currently too few. Susan Montgomery of the University of Southern California noted that surprisingly few new Ph.D.s were getting positions in doctorate-granting institutions. Noting the increase to 900 new doctorates last year, she remarked that there seem to be reasonably good Ph.D.s having trouble getting jobs. "We should be cautious about trying to greatly increase the current number," she said.

Still, all seemed to agree that having postdocs more widely available would be beneficial. However, Lance Small of the University of California at San Diego objected to the way the AMS Council's entire discussion of postdocs had focused on research. "We haven't talked at all about the principal activity of new Ph.D.s: teaching," he declared. Most individuals coming off postdocs will

be applying for positions where teaching is important but evaluations of their teaching records will be scant. As Small put it, "Postdocs deserve to have a letter of recommendation beyond graduate school saying more than, 'Was a good T.A.'"

Women and Minorities

"Is graduate education meeting the needs of women and minorities?" asked Rhonda Hughes of Bryn Mawr College during her presentation at the panel on graduate education. Despite some signs of improvement, her answer was "a resounding, emphatic, No!" Institutional barriers are falling, but old attitudes are slow to change, she notes. Hughes quoted one black woman mathematician: "Mathematicians see themselves as producing the next generation, and tend to do so in their own image. There is a personal cult to graduate education, and the nurturing and mentoring that are key parts of graduate education simply do not occur the same way for these groups. It is difficult for most white males to see blacks and women as their successors." Hughes also pointed out that women and members of underrepresented minorities are often considered "risks" if they are underprepared or have unusual backgrounds. Even though the unproductive mathematicians in most mathematics departments are often white males, she declared, "we don't recall hearing about the risks these once-promising mathematicians posed."

According to Hughes, the biggest obstacle is the small number of women mathematicians being hired at the top universities, but she concedes it's a "very touchy issue." Promising women mathematicians are very much in demand in academia, but the top departments say there are not enough of the high-caliber women to go around. "They say, 'we called all the top ten women and none wanted to come or none was available,'" said Hughes. "Well, I say, what about the fifteenth?" She explained that it's not a matter of lowering standards to let more women in, but rather of balancing diversification of the faculty with the needs of the research mission.

In a community where "research *über alles*" prevails, many will find such a proposal hard to swallow. Hughes revealed another wrinkle: "You point out [these departments] that there are people they hired some years back who aren't all that great," said Hughes. "They say, 'Oh, but in those days, we weren't so careful as we are now.'" At this point the audience burst into laughter. Her retort? "Right, but you hired all men those days."

Allan Jackson
Staff Writer

Computers and Mathematics

Edited by Jon Barwise

Editorial notes

Computers at the annual meeting

I stopped going to the Annual Meetings in the mid 80's. I found they had become dull and even somewhat depressing. And I never felt that I learned any mathematics from the talks. Maybe it was just a reflection of the hard times mathematics was going through at the time, due to the job market. Or maybe it was me. I don't know. In any event, I would not have thought about going this year if I had not been asked to give an invited address.

I am glad I went. There was quite a different and more exciting atmosphere at the meeting than I can recall in years. The meeting was much better organized than I remember. Most important, though, it seems that we are becoming much more attentive to the task of communicating mathematics—to the public, our students, and even each other. This attitude was palpable in Louisville. The invited lectures were more accessible and stimulating. There were good sessions on teaching mathematics. And there were interesting events of other sorts, like the memorable session on the play *Breaking the code* (*The life of Alan Turing*) with Peter Hilton and the play's author, Hugh Whitmore. Altogether, a pleasant surprise.

I was also surprised at the extent to which computers were in evidence in various ways: in just behind the scenes in some of the invited talks, in sessions on the use of computers in teaching mathematics, and in the exhibition hall. The amount of mathematics-related software available at the meeting was impressive. And the interest in the sessions on using computers in the classroom was also much greater than I anticipated. The times really are changing.

One thing hasn't changed, though. The message station. It is hard to believe that in 1990, well into the Information Age, we were still trying to get information to one another by writing it on grubby little scraps of paper, sticking it into cubby holes, to be sorted and resorted by every person with a name between "Nom" and "Mus." I stood and timed this process for a while. During my watch, it took between four and ten minutes per person to find out whether they had any messages. The longer times were typically due to people shamelessly reading out other people's messages. And I saw people drop messages without realizing it, as they were rifling through the slips. There must be, or should be, software available for this sort of thing. Surely a simple *Hypercard* stack on a couple of Macintoshes would have been quicker, more private, and more reliable. So my suggestion for an additional improvement to the meetings is to have someone spend a little thought on computerizing the

message station.

Time for a change in the column?

The changing role of computers evidenced at the meeting prompts me to wonder whether it isn't time for this column to shift its emphasis a bit. Our mathematics departments are now well on the road to using computers in the classroom and in writing mathematics. But what about research? There is less evidence that as a group we are learning how to exploit the computer in our research.

This imbalance has been reflected in this column. There have been quite a few articles related to teaching and writing mathematics, fewer about the use of computers in research. Frankly, I have had a hard time finding authors for research related articles. I urge readers to suggest research related software that should be reviewed, as well as other sorts of articles on the use of computers in mathematical research. If you have a suggestion for an author of such a paper please let me know.

Professor Jon Barwise

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After July 1, send it to me at my new affiliation:

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Bloomington, IN 47405

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This month's column

This month's column contains a discussion of *TEX*, by Michael Doob. He starts with a general overview and then discusses versions that are available for the Macintosh. He will discuss PC versions in another issue.

The column also contains several interesting reviews of mathematical software. I would like to draw special attention to two. One of these, by Colin Adams, is of a research related program, Jeff Week's hyperbolic 3-manifold program *SNAPPEA*, mentioned in January's editorial. The other is a review of *Derive*, by Phil Miles. Miles reviews *Derive* in the context of pre-calculus teaching, and raises an important pedagogical issue. I would welcome thoughts on the problem Miles poses.

TeX and the Single CPU

Michael Doob
University of Manitoba

Some of the tools used by computer scientists are purely mathematical, and, perhaps because of this, there is an assumption that most mathematicians, in return, easily use computer-oriented tools. It is my (completely unscientific) observation that in fact there are two types of mathematicians: those who think that small microcomputers are the greatest thing since sliced bread and jump at the opportunity to use new software, and those who think that computers are complicated beasts that are, at best, difficult to master and must be approached with some trepidation. There have been many reviews written for this column, **Computers and Mathematics**, by mathematicians of the first type. I think, however, that this group is in the minority among all mathematicians, and it is to the rest, the majority, that this article is addressed.

There are several purposes to this article. First, we'll get an overview of the mathematical typesetting program TeX, not in the technical sense of bits and bytes and that sort of thing, but rather as an idea of what's going on from the user's viewpoint. It is not an overstatement to say that this single program is revolutionary, as has been indicated in earlier articles in this column. The impact could be as great for the communication of mathematical ideas as was the motor car for transportation. This article, by analogy, is meant to show how to get your own car, try out the gas pedal and the brake, and then how to go from point *A* to point *B*; we won't be concerned with the inner workings of the engine.

After that we'll look at several implementations of TeX on some microcomputers; while we'll be mainly interested in the IBM-PC compatibles and the Macintosh, the predominant hardware in North America (with apologies for this geographic egocentrism), we will comment on others in passing.

So first, in the usual mathematical tradition, we will be sure that we are working with a good set of definitions. TeX is a program whose purpose is to produce printed pages of mathematical text of quality that is equal to the highest standards of typesetting. This is a formidable task, for not only are there many different symbols used, but there are also many subtle conventions that are normally employed for mathematical text. This is why TeX is a large and complicated program, and has only appeared on the microcomputer in the past few years. It is also why many other programs, even those with built-in symbols and mathematical fonts, produce ugly mathematical output. Fortunately, although the program

itself is complicated, the use of it is less so. Here is a typical process you go through to prepare a paper:

1. Use any editor (the simpler the better) to prepare what is called a *source file*. This will contain the text that you want typeset. The usual text is typeset in normally, while special words starting with a backslash are used for symbols: \alpha is used for α , \beta is used for β , and so forth. There are also commands for positioning the mathematics so that, for example, equations can be centered, numbers can be attached to them for reference from within the text, and other similar things can be done. When desired, many fine details can be controlled, but most of the time text is entered in a reasonably straightforward way.
2. When the source file is complete, it is used as input for the TeX program. As the program runs, status messages from the program to the user are printed on the computer screen and also in a *log file*. When the program is finished, another file called the *DVI file* will have been produced.
3. The DVI file is not readable, at least not by humans. To see the finished product on the computer screen, it is necessary to have another program called a *previewer*. This has nothing to do with TeX, but, of course, and, unlike the output of the TeX program, is necessarily dependent on the particular type of computer being used. Unless you are perfect from the first try, it is then necessary to go back and edit the source file some more. It's not unusual to have several passages through the edit-TeX-preview cycle.
4. When the output is just the way you want it, a *printer driver* program is necessary to print the output on an actual sheet of paper.

Thus we see that to use TeX we must not only have the program itself, but we also need an editor, a previewer and a printer driver. Further, although a given source file will result in the identical DVI file when used with any version of TeX, some implementations are more efficient than others.

There are several variations called *macro packages* which may be used with TeX. These are, roughly speaking, new commands that are added to the standard TeX. By far the best known ones are L^ATeX and A^MS-TeX. The former allows for much more general typesetting, including such things as tables of contents, indexes, and some elementary graphics. The latter is a standard set of macros that may be used when submitting articles to certain journals of the American Mathematical Society.

The preparation of the source file is essentially a secretarial task, and may not be palatable to some mathematicians. In this case, the comparisons that follow may be of interest to secretaries who use a microcomputer. But even if you never want to type a source file,

are still interesting reasons to use T_EX. One is as a tool to allow mathematical text to be passed through the electronic networks. *Mathematical Reviews*, for example, will accept contributions in a T_EX format. There are commercially available CD-ROMs that contain the last five years of the same publication, with all reviews in T_EX format. So the T_EX program along with a device driver for printing output is of interest to the mathematician even if he or she does not want to type any papers.

We should also note that there are both commercial and public domain versions of T_EX available. So, one would naturally ask, why buy a commercial version when the public domain version can be had for free (or at least for the cost of the diskettes)? As a general rule, the commercial versions provide two things that are superior to public domain versions: there is much better documentation, and there is telephone support. Also, there is usually easier installation. So, if all other things are equal, and you have a buddy who is used to the ins and outs of your computer, you might give the public domain versions a shot. On the other hand, if you're really in a hurry and are on your own, the commercial versions might be more of your cup of tea.

Now let's look at the different implementation of T_EX. This is a little tricky since new versions and variations of old ones are appearing all the time. I shall only talk about ones that have been around long enough to be stable.

There are two versions of T_EX available for the Macintosh. One of them, *Textures* is commercial, and the other, OzT_EX, is public domain. There is quite a difference in the philosophy of these implementations.

Textures comes with *The T_EXbook* (the standard reference about T_EX), a user's guide with installation instructions, and six diskettes. Installation is relatively easy; it is just a matter of creating one folder, copying the six diskettes into it, moving one set of fonts with the Font/DA mover, and moving seven "suitcase" files into one of the copied folders.

Textures uses approximately 4.5 megabytes of space on your hard disk when fully installed. While it is just possible to get it running on a Mac Plus with one megabyte of memory, two or more megabytes of memory is really much better.

Having done this, the user now has a T_EX system available with pull-down menus to access windows that contain the source file, the previewed output, and the log file. It is also possible to print the file on either an Apple LaserWriter or ImageWriter by another pull-down menu. (See graphic on following page). The fact that you can edit your source file, run T_EX, and preview the results all from within the *Textures* program is both unique and very helpful when learning T_EX. The quick feedback to the user makes the spotting and correcting errors easy. In addition, the previewer is

superb. Particularly striking is its ability to give legible screens at an almost continuous range of magnifications. But there is a price to be paid for this bundling. The DVI file is not created, at least not directly, and a special desk accessory must be installed to import or export DVI files from the program. In addition, the use of new fonts is somewhat less straightforward, and the L^AT_EX and A_MS-T_EX macro packages must be purchased separately. Also, while over 70 fonts may seem like a lot (and indeed would be more than adequate for most work), the *full* set of (Computer Modern) T_EX fonts require an extra purchase. In summary, *Textures* is really wonderful for the new user, but there is a potential for problems when getting into more unusual applications. *Textures* is available from Blue Sky Research, 534 Southwest Third Avenue, Portland, Oregon, 97204, at an educational price of \$395. The L^AT_EX package costs \$75, the A_MS-T_EX package costs \$90. The package of extra fonts costs \$85.

In contrast, OzT_EX is a different implementation in almost every way. First of all, it is in the public domain. That means that you may make copies of it and install it as you wish. It does not, however come with *The T_EXbook*, which you will surely need, nor does it come with printed installation instructions. It does come on ten diskettes, with a short introduction on the first one. It is necessary to adjust a configuration file, and then to print out further instructions if necessary. There is a good user's guide, but it is written in L^AT_EX! While OzT_EX uses separate programs for running T_EX and editing, a desktop accessory editor called *Σedit* is included. It may be necessary to use a resource editor to make the configuration file accessible.

When OzT_EX is loaded into the Macintosh, it uses just over 5 megabytes of space on the hard disk. Like *Textures*, it can run with only one megabyte of memory, but it really needs two or more megabytes of ram to run easily.

When OzT_EX is run, a screen with different pull-down menus appears. Running T_EX will cause a dialogue box to appear which asks for the input file in the usual Macintosh manner. OzT_EX then produces a DVI file and a log file as mentioned above. There is also a pull-down menu for previewing the file. (See graphic on following page). As a result, the DVI files produced by OzT_EX may be used by other machines, and DVI files produced by other machines may be previewed by OzT_EX. The previewer is definitely slower than that of *Textures* as it paints the fonts on the screen, and there is less flexibility with magnification sizes. This may be a problem with the usual (small) Macintosh screen. Nonetheless, the previewer produces legible screens and are quite usable. OzT_EX also includes the ability (via a pull-down menu) to convert the DVI file to a PostScript one and send it to a LaserWriter or other PostScript printer. There is no printer driver for the ImageWriter.

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Theorem 3. For any $j \geq 1$ and $r \leq -(\tau^{\frac{1}{2}} + \tau^{-\frac{1}{2}})$, there exists a sequence of nonnegative integers $\{n_i \mid i = 1, 2, \dots\}$ such that

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Theorem 3. For any $j \geq 1$ and $r \leq -(\tau^{\frac{1}{2}} + \tau^{-\frac{1}{2}})$, there exists a sequence of nonnegative integers $\{n_i \mid i = 1, 2, \dots\}$ such that

$$\lim_{k \rightarrow \infty} \lambda^j(T(n_1, \dots, n_k)) = r.$$

Theorem 3 follows from Theorem 2, since our construction will only use trees in \mathcal{T} , and, since trees are bipartite, they have a symmetric spectrum (see [1], for example).

Proposition 4. Suppose G is a graph with n vertices and eigenvalues $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_n$. H is formed by taking t copies of G , one additional vertex v , and arbitrarily adding edges joining v to the copies of G . Then λ_1

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OzTeX

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Theorem 3. For any $j \geq 1$ and $r \leq -(\tau^{\frac{1}{2}} + \tau^{-\frac{1}{2}})$, there exists a sequence of nonnegative integers $\{n_i \mid i = 1, 2, \dots\}$ such that

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Theorem 3. For any $j \geq 1$ and $r \leq -(\tau^{\frac{1}{2}} + \tau^{-\frac{1}{2}})$, there exists a sequence of nonnegative integers $\{n_i \mid i = 1, 2, \dots\}$ such that

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OzTeX comes with all that is necessary to use L^AT_EX, and it is also possible to make A_MS-T_EX from the source file. In addition, it is easy to add new fonts by putting appropriate files into folders.

Which of the two programs is faster? I used my own 95 page *Gentle Introduction to T_EX* as a test file. This introduction has a mixture of straight text, mathematical text, and tables (it is available from the T_EX Users Group, P.O. Box 9506, Providence, RI, 02940, for \$15). *Textures* produced the (quarter megabyte) DVI file in 8 minutes and 32 seconds while OzT_EX took 10 minutes and 22 seconds.

There is one other item of note. Often *Textures* and OzT_EX are used with the Apple LaserWriter (PostScript) printer. It is then of interest to insert illustrations (say from MacDraw or MacPaint), to use the PostScript fonts, or to use the PostScript language. Both implementations allow this using the T_EX \special command or special names for the PostScript fonts that the T_EX \font command understands.

OzT_EX is available from Stephen Spencer for \$30. He may be contacted at spencer@cis.ohio-state.edu, or at OSU - ACCAD, 1224 Kinnear Road, Columbus, Ohio 43212. The author of OzT_EX is Andrew Trevorrow, Kathleen Lumley College, North Adelaide, S.A., 5006 Australia.

Reviews of Mathematical Software

SNAPPEA The Weeks Hyperbolic 3-Manifolds Program

Reviewed by Colin Adams
Williams College

Introduction

This article reviews the mathematical software SNAPPEA, also known as the Weeks Hyperbolic 3-Manifolds Program. It was written by Jeff Weeks with support from the Geometry Supercomputer Project. A version of the program which runs on a Macintosh with at least 512 K is available from Jeff Weeks, c/o Geometry Supercomputer Project, 1200 Washington Ave. So., Minneapolis, MN 55415 (email address weeks@poincare.geom.umn.edu). Please specify what model Macintosh you use (for the newer Macs, the program can be compiled to make direct calls to the floating point coprocessor).

Background

In 1978, Thurston revolutionized the field of 3-manifolds by proving that many 3-manifolds could be decomposed into submanifolds, each of which had one of eight geometries. Thurston has conjectured that in fact all compact 3-manifolds can be so decomposed. The manifolds corresponding to seven of the geometries have been classified. The eighth geometry is that of hyperbolic 3-space.

In order to understand the class of hyperbolic 3-manifolds, it was necessary to compute some examples. Thurston calculated several examples by hand (cf. [4]), however both the combinatorics and the equations that are generated quickly become too difficult to handle without a computer. Several people worked on programs that calculated hyperbolic structures on certain 3-manifolds. In particular, Bob Riley had the first such calculations, but also Daryl Cooper, Martin Hildebrand, Bob Meyerhoff and I worked on programs.

In 1985, Jeff Weeks, then finishing his Ph.D. under Thurston, wrote his first version of a hyperbolic 3-manifolds program. Since then, it has undergone numerous mutations. It is now the state of the art in such programs and an indispensable tool for anyone interested in hyperbolic 3-manifolds or knot theory.

For background on hyperbolic 3-manifolds, [3] and [5] are helpful. More information on the particular invariants appears in [1]. Thurston's notes [4] generated the field of hyperbolic 3-manifold theory.

The Program

I will first describe how to use the program to find the hyperbolic structure of a knot or link complement in S^3 . The program comes with a folder containing all knots of ten or fewer crossings and all links up to nine crossings. However, if you want to enter your own knot or link, you just click on an icon with the name "Crumble". A blank screen appears and you can then use the mouse to draw a rectilinear knot or link. The program picks arbitrarily whether each crossing will be an over or under crossing. Once you are finished drawing the link, you can then go back and change the crossings by clicking on them. Also, there is an option on the menu bar that automatically makes the link alternating.

Then, you save the link as a file in the folder with all the other links. Links are stored as a sequence of numbers and the current program cannot regenerate the picture of the link, so judicious naming is important for remembering which link is which. (Jeff Weeks plans to include the option of saving pictures of links in the next version of the program).

Now you click on an icon called "Triangulate". This program takes whatever link you give it and cuts the complement of the link up into ideal (vertices missing) tetrahedra. In the case that the link complement is hy-

perbolic, it is known that the triangulation algorithm will always succeed. For many other links, the program will also yield a triangulation. However, there are examples of non-hyperbolic links for which the algorithm will not generate a triangulation. (In fact, the vast majority of links are hyperbolic, so a random choice of link will rarely stump the algorithm.)

The program then attempts to place the ideal tetrahedra in hyperbolic 3-space so that the angles around the edges add up to 360 degrees and so that the tetrahedra fit together appropriately to yield a complete hyperbolic metric on the manifold. This entails solving numerically a system of n complex polynomial equations in n unknowns. The theory implies that when the manifold is hyperbolic, the system of equations has a unique solution, however the program is not guaranteed to find it. In practice, the program has never failed to find the solution for a manifold known to be hyperbolic.

The solution to the system of equations yields the appropriate dihedral angles on the ideal tetrahedra so that one obtains the hyperbolic structure. The hyperbolic volume of the link complement is then calculated out to fifteen decimal places.

Once the program has stored the triangulation of the manifold, you can run either "Pretty Pictures" or "Dehn Filling", each of which is opened by clicking on the appropriate icon. "Pretty Pictures" takes as input any link that "Triangulate" has been run on. (It can also be run on any cusped hyperbolic manifold for which an ideal triangulation is known.)

The program first retriangulates the manifold utilizing the hyperbolic structure that was computed in "Triangulate" to obtain a canonical triangulation independent of whatever projection of the link you started from. It then calculates several invariants of the hyperbolic structure, including the maximal cusp volume and the conformal invariant of the cusp.

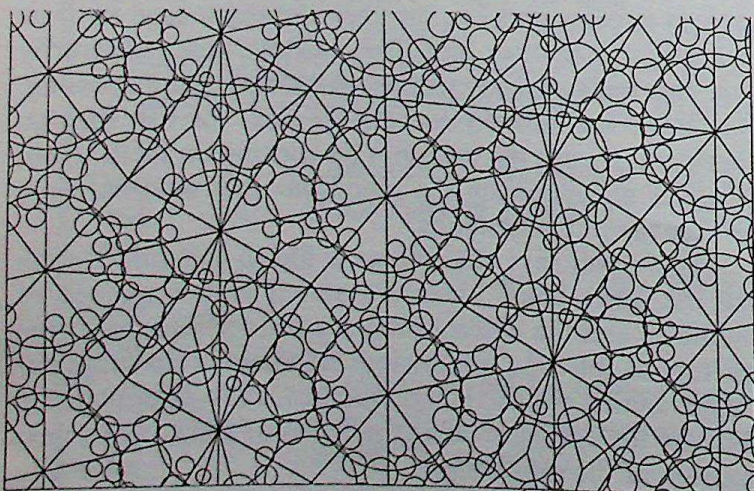


Figure 1. Horoballs and triangulation corresponding to 6_2 knot

A blank screen with a menu bar then appears. When you pull down the menus, you are provided with such

options as "Ford domain", "horoballs", "triangulation" and "parallelogram". You choose which of these items you would like to have displayed on the screen. The picture that the program then generates is a view from up on the positive z -axis looking down at the x - y plane in the upper-half-space model of hyperbolic 3-space. Since hyperbolic 3-space is a covering space of the given hyperbolic 3-manifold, you are seeing the lifts of the hyperbolic 3-space of various objects from the original link complement. For instance, "triangulation" displays the tiling of hyperbolic 3-space by ideal tetrahedra which cover the ideal tetrahedra in the triangulation of the link complement. "Horoballs" shows the lift of the maximal cusp in the manifold to a set of disjoint horoballs in hyperbolic space.

For each component of the link, the computer will generate a new picture. If you have a color monitor, the computer displays horoballs corresponding to distinct components of the link in different colors.

The "Dehn Filling" program allows one to investigate manifolds which are obtained by Dehn surgery on links in the 3-sphere. Since all compact 3-manifolds without boundary can be obtained this way, the potential of this program is immense. (Although, as it now stands, this program does not give any insight into the structure of non-hyperbolic 3-manifolds, there are some possibilities for extracting information using this program even in that case.)

"Dehn Filling" takes as input a link on which "Triangulate" has already been run and a choice of surgery coefficients on the components of the link. The program then finds the hyperbolic volume of the resulting surgery manifold, if it can. For larger surgery coefficients the program always succeeds as the resulting manifold has a hyperbolic structure close to that of the original manifold. However, for small coefficients, the program is not guaranteed to succeed even if the resulting manifold is known to have a hyperbolic structure.

Many conjectures have been generated from the data obtained from this program. For example, the minimal volume hyperbolic 3-manifold conjectured to be the minimum volume hyperbolic 3-manifold was discovered by Jeff Weeks using his program [6]. J. Weeks and M. Hildebrand utilized the program to obtain a census of hyperbolic 3-manifolds with triangulations of five or fewer ideal tetrahedra. The first orientable hyperbolic 3-manifolds obtained from six or fewer ideal tetrahedra [2]. C. Hodgson, R. Mehta, and W. Neumann have utilized the program to calculate the Chern-Simons invariant. L. Mosher has applied the program to punctured torus bundles.

An extension to the program which calculates the length spectrum of hyperbolic 3-manifolds was written by D. Hoffoss while at the Geometry Supercomputer Project. C. Gunn, also at the Geometry Supercomputer Project, has written a program to display the Dirichlet domain

for these manifolds. Since the program's inception, Weeks has continued to expand and improve it.

This program has already had a large impact on low-dimensional topology. As it continues to evolve, it will be a crucial source of examples and conjectures for many years to come.

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DERIVE as Precalculus Assistant

Reviewed by Phil Miles*

Derive styles itself a mathematical assistant. It is intended to do far more than standard precalculus problems, and I have colleagues who use it in these grander capacities. But it does do many standard precalculus problems, and precalculus is a course with very large enrollments. The National Research Council appears to favor the idea of a precalculus assistant, saying "Weakness in algebraic skills need no longer prevent students from understanding ideas in more advanced mathematics. Just as computerized spelling checkers permit writers to express ideas without the psychological block of terrible spelling, so will the new calculators enable motivated students who are weak in algebra or trigonometry to persevere in calculus or statistics." (*Everybody Counts*, p. 62).

The demands of *Derive* are relatively modest - a PC compatible computer running DOS and having 512K memory and a graphics adapter. While not the same as being available in a "pocket computer", this is in the right ball park for a precalculus assistant.

A good assistant is biddable and forgiving. One can give it instructions without troubling to know its

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psychology, and if one gives it the wrong instructions, one can redirect it quickly and without resistance. *Derive* meets these tests. It displays your input in classic "two-dimensional" notation so you can readily see whether you have entered what you intended. It usually ignores keystrokes which are irrelevant to the current context, sometimes giving a warning beep. And, for times when you regret your original instructions, it has a very easy escape from its current procedure. (Exception: when you want to quit, the program waits for directions on saving recent input. The prompt for these instructions is not displayed when in the text mode, so the program appears to be hung.)

I started working with *Derive* before opening the manual, and used the manual only as necessary to proceed. This worked very well. The major commands of algebra - expand, factor, plot, simplify, solve - appear on the main menu as single keystrokes and, on the whole, do what one expects. A certain amount of "target-seeking behavior" is necessary for this approach. The default parameter settings result in taking roots and solving equations over the complex numbers and do not do certain trig and log expansions. A handy system of sub-menus allows you to tinker with the parameter settings until the desired result is obtained. A quick look at the manual will suggest a likely sub-menu; cut-and-try will get the right setting. With about an hour's experimentation, I was ready to proceed.

On my department's placement test, *Derive* placed out of intermediate algebra and into the precalculus course which immediately precedes scientific calculus, answering correctly almost all the algebra questions. With mechanical transcription supplemented by some cut-and-try, it answered 39 of 67 questions. With transcription, which included entering verbal problems as equations, its scores rose to 48. It cannot do questions emanating from geometry, and these account for almost all the missing answers. Interestingly, this lack prevented *Derive* from placing out of trigonometry despite its ability to do trig equations and identities. Once into precalculus, *Derive* retains its ability to do algebra (in contrast to humans) and can do many exam questions on logs and exponentials (though limited by a disinclination to make substitutions). It can form rules for composite functions and materially assist in finding the rules for inverse functions (e.g., if you tell it to switch and solve, it will do the switching and solving). It can do linear simultaneous equations, but not even simple non-linear ones.

The target-seeking behavior I used in getting answers from *Derive* is certainly natural for students operating in the classical pencil-and-paper context. For a target, they generally have the answer in the back of the book. They use the powerful operators DISTRIBUTE, MOVE and CANCEL in conjunction with the four operations of arithmetic to rearrange and delete symbols until the

target is attained (see below). I believe they could adapt their behavior to this program with minimal difficulty. So I judge *Derive* is a precalculus assistant in a certain fairy story sense.

The magical assistants in fairy stories grant wishes speedily, effortlessly and in a way that makes the wisher rue the wish. I suggest that algebra utilities may come to play a similar role in mathematics instruction. Precalculus students know the letters of a mathematical statement, but not the words. They see "a⁹" as the concatenation of an "a" and a special "9", not as a word meaning the product of nine a's. A complicated word like $e^{-2\ln 3}$ is seen as a string of symbols from which the powerful operator CANCEL permits deletion of "e" and "ln", leaving $-2(3) = -6$.

English spelling looks arbitrary because it is largely a record of etymology, and in natural language, etymology is unrelated to meaning or usage. In mathematics, spelling can be considered as etymology, but etymology in this sense exactly determines meaning and usage. Our example $e^{-2\ln 3}$ traces back to $1/e^{2\ln 3}$, thence to $(1/e^{\ln 3})^2$ etc. Algebra instruction is ideally an effort to get students to see words whose spelling gives their meaning. Students are disposed to do letter-by-letter symbol manipulation instead. Present teaching practice apparently often supports such an approach—perhaps by soft grading, perhaps by use of simplified and stereotyped problems. Students who are supported in a letter-by-letter approach are thereby supported in their belief that the language of mathematics is meaningless.

Use of an algebra utility can eliminate the need to know the words and usage of algebra—the core of the language of applicable mathematics. Unquestionably one can *persevere* in calculus on this basis—many students already do so without benefit of algebra utilities. Whether one can find *meaning* in doing so is doubtful. And it is a serious question whether colleges can prosper without imparting a greater sense of meaning to their curricula.

The existence of algebra utilities raises a serious problem for teachers of mathematics. Teaching is hard. One must engage oneself with one's students and work to engage them with the material. After making these efforts, an ordinary teacher must still admit to failure in the case of many students. Doing all this when a perfect version of The Answers lies only a few keystrokes away will be hard indeed. This difficulty will weigh upon teachers' minds whether or not such a utility is actually in the hands of their students.

Editorial comment: I can't resist commenting on the worry raised in Miles' review. I share the concern expressed, that symbolic mathematics packages may make it even harder for our students to understand the meaning of mathematics. It will be a disaster if the use of such programs makes mathematics look even more like a formal game than it does to students already. My

own suspicion is that mathematical courseware has to be developed with this pedagogical problem squarely in mind.* It is not going to work to just use software capable of doing symbolic manipulations. I will be interested in the reactions of others.

ISETL - Interactive Set Language

Reviewed by Donald L. Muench**

ISETL is an interpreted, interactive implementation of the high-level computer language, *SETL* (SET Language) whose syntax is very close to mathematical notation. It contains the usual collection of statements common to procedural languages, but a richer set of expressions. The objects of *ISETL* include finite and heterogeneous sets and tuples, integers, floating point numbers, functions (function sub-programs), and strings. It was developed so that it can be used effectively in the teaching and learning of mathematical concepts. Indeed, an innovative textbook treating the traditional topics of discrete mathematics was published in late 1988 by Springer-Verlag, "Learning Discrete Mathematics with *ISETL*", written by Nancy Baxter, Ed Dubinsky, and Gary Levin. Gary Levin is the implementer of *ISETL*. I have used this text and the software for three semesters in discrete mathematics.

ISETL is "shareware" and is available from Gary Levin, Department of Mathematics and Computer Science, Clarkson University, Potsdam, NY 13676 and may be freely copied. It runs on IBM PCs under MSDOS and compatibles, Macintosh, (diskettes and documentation cost \$20) and the VAX under either VMS or UNIX (tape and documentation cost \$25). Since the source code (also freely available) is written in C, *ISETL* should be able to run on any machine having a C compiler. In 1988 *ISETL* was a finalist in the EDUCOM/NCRIPT awards competition for best educational software.

The version reviewed here is *ISETL* 2.0 (Oct 1988) under MSDOS.

Right at the start I want to say that I am excited about, and impressed with, *ISETL*. It is easy to learn and easy to read and write. Students with no previous programming experience have little difficulty learning the language. To a mathematician the close syntactic resemblance to standard mathematical notation is particularly appealing. What got me started in it was a Saturday afternoon tutorial by Ed Dubinsky and Nancy Baxter.

*John Etchemendy and I wrote on the potential and challenges of creating such courseware in the January 1989 column.

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at the IFRICS program at Clarkson in the summer of 1985. It was there that I met Gary Levin. What captured my attention was this one-line *ISETL* statement which generates the set of prime numbers between 2 and 50 (the ">" is the *ISETL* prompt for input):

```
> {p : p in {2..50} | (forall d in {2..p div 2}
    | p mod d /= 0)};
```

This is nothing more than the precise mathematical definition and yet it is a statement in the language which, upon hitting RETURN, produces the output,

```
{37, 29, 31, 19, 23, 13, 17, 47, 43, 41,
 3, 2, 5, 7, 11};
```

So, by specifying the definition in careful mathematical notation, we have a valid *ISETL* expression. This gives a flavor of the power of *ISETL*.

Sets and Tuples

The previous expression shows that *ISETL* supports sets and quantified expressions. The reader will also note that the output is a set of elements displayed in no pre-set order. That is because sets do not order the elements. However, tuples (sequences) do impose an order on the elements. A tuple can be formed by using square brackets, thus ordering the elements. Hence, we can create a tuple of the primes between 2 and 50 with this statement:

```
> [p : p in {2..50} | (forall d in
    {2..p div 2} | p mod d /= 0)];
```

and produce the output,

```
[2, 3, 5, 7, 11, 13, 17, 19, 23, 29,
 31, 37, 41, 43, 47];
```

Tuples may have any length and elements can be assigned and placed in the tuple at any position. Thus if we have

```
> t := [5, 9, "Leo", 10, 3];
```

where ":= " is the assignment operator, the statement,

```
> t(3);
```

asks for the third entry in t and immediately produces the output,

```
"Leo";
```

Furthermore, we can make this assignment,

```
> t(8) := 44;
```

and examine t by

```
> t;
```

and see the immediate output,

```
[5, 9, "Leo", 10, 3, OM, OM, 44];
```

The value "OM" means "undefined". This dynamic allocation and assignment of values combines all the advantages of an array and a dynamic linked list in one data structure.

Among the operations which can be performed on sets are union ("+" or "union"), intersection ("*" or "inter"), difference ("-"), and power ("pow"). Thus,

```
> s1 := {5, 9, 8};
> s2 := {[2, 7], 5, "Greg", 9};
> s1 inter s2;
```

produces

```
{5, 9};
```

and

```
> pow( {5, 9} );
```

gives

```
{ {5}, {5, 9}, { }, {9} };
```

The language is rich enough to permit the user to define new sets and operations such as Cartesian product and symmetric difference. New operations are defined as functions of two variables, using the type func.

Functions

The function notation is used in tuples and strings to access particular elements or characters. In the previous tuple t, t(3) has the value "Leo". Thus a tuple (sequence) can be used to represent a function whose domain is a set of positive integers and whose image is the set of non-OM elements in the tuple.

However, this isn't the only way to represent a function in *ISETL*. A function is statically defined as a set of ordered pairs in which any two pairs with the same first element must have the same second element. For example we can define

```
> f := {[12, 6], ["brady", {5, 2}],
    [2, 8], [3, "neon"]};
```


Here, the domain is {12, "brady", 2, 3} and the image is {6, {5, 2}, 8, "neon"}. In *ISETL*, two predefined functions can be used to find the domain and image:

```
> domain(f);
{12, "brady", 2, 3};
> image(f);
{6, {5, 2}, 8, "neon"};
```

Having defined *f* in this way, we can evaluate *f*(12) or *f*("brady") by typing:

```
> f(12); f("brady");
```

and obtain the output,

```
6;
{5, 2};
```

ISETL does not have procedures or subroutines, but does have funcs, which syntactically are reminiscent of Pascal functions (without all the type declaration baggage), with the added advantage that ANY *ISETL* object(s) may be passed to or returned by a func. For example, given a positive integer *n*, we want the set of the proper divisors of *n*. All we have to do is form the set in a precise way ($\{d : d \text{ in } \{2..n-1\} | n \bmod d = 0\}$) and wrap it in the correct syntactical blanket. Here is the definition of this func (the ">>" prompt asks for more input from the user):

```
> PropDiv := func(n);
>>   if is_integer(n) and n>0 then
>>   return {d : d in {2..n-1} | n mod d = 0};
>>   end if;
>>   end func;
>
```

So, if we type

```
> PropDiv(6);
```

we will see the returned value,

```
{2, 3};
```

As another example, we can pass two functions and return their composition. The composition operation accepts two functions and returns a function. Therefore, we can define the operation of composition,

```
> comp := func (u,v);
>>   return func(x);
>>   return u(v(x));
>>   end func;
>>   end func;
>
```

We can compose the func *PropDiv* and the set of ordered pairs *f*, defined above, and evaluate the composition at a point in its domain. Consequently, if we type

```
> comp(PropDiv,f)(12);
```

we see its value,

```
{2, 3};
```

Boolean Expressions and Operations

ISETL also supports boolean expressions and the operations of "and", "or", "not", and "impl" (implies). With a for-loop iterating over a set, tuple or string, one can print out a truth table for rules such as DeMorgan's Law

```
> for p,q in {true,false} do
>>   writeln p,q, not(p and q)
>>   iff (not p) or (not q);
>> end for;
```

Hence, *ISETL* may be used to investigate the validity of arguments, and to study propositional calculus.

The Screen Editor Interface (MSDOS Version)

At the MSDOS prompt, typing

```
isetl
```

puts us immediately into *ISETL* and the screen editor. This editor is very easy to use. We can send lines to *ISETL* by typing them and entering RETURN. Using the arrow keys, groups of earlier lines can be edited and executed again.

There is a menu (entered by the ESC key) which contains selections for saving groups of lines into a file or saving the whole *ISETL* session into a file. Both of these features facilitate the preparation of input and output for handing in exercises by students. Another selection permits the reading of a file of *ISETL* code. Upon hitting "RETURN", the code is executed.

Uses of *ISETL*

I am personally aware of several uses of *ISETL* in mathematics, besides its use in discrete mathematics (see the book by Baxter, et al.). Because of its mathematical syntax, *ISETL* has inspired new uses in calculus (see Dubinsky at Purdue, also using the computer algebra system *MAPLE*) and introductory probability (see Lebow at Yeshiva). Textbook projects are currently underway now which use *ISETL* in calculus (along with the computer algebra system *MAPLE*) and abstract algebra. Some illustrations are in order.

In discrete mathematics *ISETL* makes it possible to think of functions in concrete ways which are familiar to mathematicians: as a set of ordered pairs and as a dynamic process. Of course, not every set of ordered pairs is a function. In a class, students would be invited to write a "tester" that tests a map and tells whether or not it's a function. If we define it to mean that two pairs with the same first element must have the same second element, then we have the following:

```
> is_function := func(M);
>   if is_map(M) then
>     return forall u,v in M | u(1)
>       = v(1) impl u = v;
>   end if;
> end func;
```

An *ISETL* func captures the idea of a dynamic process, where the body of the func is a description of the process.

As an example of its use in calculus (due to Mark Huibregtse of Skikmore), consider how the Riemann integral is defined in most books. In this example *ISETL* can help build Riemann sums (in this case midpoint sums). This leads to a func for making midpoint estimates of definite integrals. The body of the func below was developed right in class ("%" is *ISETL*'s summation notation). Notice that midpts is the sequence of midpoints of subintervals and that heights is the sequence of function values at the midpoints.

```
> MidRiemann := func(f,a,b,n);
>   local delta,midpts,heights,areas,areaSum;
>   delta := (b - a) / n;
>   midpts := [ (a + delta/2) + j *
>     delta : j in [0..n-1] ];
>   heights := [ f(x) : x in midpts ];
>   areas := [ delta * h : h in heights ];
>   areaSum := % + areas;
>   return areaSum;
> end func;
```

The nice thing about this calculation is how exactly it corresponds to the concept of Riemann Sum. To find the Riemann sum of the sine function from 0 to pi with n = 100, one simply enters:

```
> MidRiemann(sin, 0, 3.1415926, 100);
```

The interactive nature of *ISETL*, the natural implementation of recursion, and the syntactical similarity to Pascal (which includes the usual control structures of if-then-else and while-do and for-do) make it eminently suitable for teaching and learning computer science. It

is being used in an innovative introductory computer science course at Dickinson College (Nancy Baxter) and in programming languages (Tim Budd at Oregon State).

The concepts of group theory can be expressed naturally in *ISETL* by defining a set (G) and its operation (op). For example, the identity element can be found by the expression ("arb" selects an element from the set) :

```
> arb( {e:e in G|forall g in G| op(g,e)=g} );
```

Encouraging results in student learning and understanding of cosets and Lagrange's theorem have been obtained in a project at Technion in Israel (Uri Leron, with Ed Dubinsky).

Other Features

ISETL has the usual predefined transcendental functions and many others such as floor and ceiling (ceil), max, min, and random. There are also input and output functions for opening and closing files, reading from and writing to files.

Integer arithmetic can be done to any degree of precision. For example, here is 625812 to the 15th power:

```
> 625812**15;
88441947633347013524989387609185053900125
6868407452024352291484380889922344\
005159354368;
>
```

Documentation and Information

The documentation is contained in "An Introduction to *ISETL*" by Gary Levin, which accompanies the software. The documentation is thorough, but is not intended as a tutorial. There are very few examples, although dozens of examples are contained in files which are included in the *ISETL* disks and tapes. The documentation is most valuable if you already know the language. But, not to worry: a friendly guidebook is now being written and will be available from West Publishing Company. I have not yet seen the draft version of the guidebook, but the author promises an easy-to-read introduction to the language.

There is an occasionally lively *ISETL* discussion group which is available to users who have access to electronic mail (UUCP, BITNET, etc.). The documentation contains information on how to join the group. Many of the improvements in the language arose from the discussion in the group.

Inside the AMS

The Membership Committee

Frederick W. Gehring, Chair

The AMS was founded to stimulate research, scholarship, and education in the mathematical sciences. The Society pursues this charge in a variety of ways, including the publication of books and journals, meetings and conferences, and various member services.

The AMS Membership Committee, which was re-activated in 1985, has two objectives. The first is to insure that the Society represents a broad spectrum of the mathematical community in order to reflect the needs and desires of this diverse group. The Committee helps to make the membership aware of AMS activities through mailings, advertisements, and personal contacts.

The second goal of the Committee is to communicate with the members to ensure that the Society is doing all it can to serve the membership. Here are some of the activities the Committee has helped to implement.

Membership Cards are mailed to all members of the Society annually. Each card contains the member's customer code and other useful information, such as the Society's toll-free telephone number and the address to use for correspondence with the AMS. Many members use these cards for identification, especially when purchasing publications at Society meetings.

Discounts on books or computer products purchased from particular commercial firms are available to Society members.

Inside the AMS, the column in which this article appears, is designed to make the membership aware of the full range of Society operations and activities.

The Information Booth at both the Annual Winter and Summer Meeting gives participants an opportunity to ask questions about Society activities and membership benefits. Members can air their suggestions or complaints (and compliments!) at the booth. Coffee and tea are served at the booth, making it a convenient place to stop for a chat with colleagues.

The Multi-Year Dues plan allows payment of dues in advance for any number of years (up to five) at the current dues rate for the coming calendar year.

The Life Membership option allows members to enjoy a reduced dues rate.

The Sponsored Membership Program was established to encourage individuals (and, ultimately, corporations) to pay for AMS memberships for those in third-world and/or currency-poor countries who would not otherwise be able to afford membership.

The 25-Year Member Banquet, held annually at the Winter Meeting, is open to all meeting participants. The banquet provides an excellent opportunity to socialize with fellow participants in a relaxed atmosphere and to honor those who have been Society members for 25 years or more.

New Members are now listed in *Notices*, together with their institutional affiliations.

Lower Fees at the Employment Register make this important service available to a wider range of employers and jobseekers.

Complimentary Membership for one year is offered to non-member participants (including students) who register at an annual Winter or Summer meeting.

Nominee Memberships are now available to a limited number of full-time graduate students at member institutions. The Committee supported this proposal because a 1988 membership survey, sent to 1200 individual members, revealed that 62% of them first joined the Society as nominees.

A Change in Services for Emeritus Members allows them to receive the Bulletin of the AMS as a privilege of membership, starting this year. Previously, Emeritus members wishing to subscribe to the Bulletin had to do so at the member rate.

No member should be made to feel like just another name in a computer system. The role of the Membership Committee is to provide avenues for members to make their voices heard in the governing of what is, after all, their Society. The Committee would like to see a broad spectrum of members involved in Society governance and solicits suggestions for new and innovative ways in which the Society can better serve its members.

For more information, contact Membership Manager

Carol-Ann Blackwood at the AMS headquarters in Providence 800-321-4AMS (800-321-4267) in the U.S. and Canada or 401-455-4115.

AMS Ad Hoc Committee on Cooperation with Latin American Mathematicians

A committee has been formed by the American Mathematical Society to help facilitate initiatives in research mathematics in Latin America and/or involving Latin American mathematicians. Although this committee has no budget for projects of its own, it hopes to get people with good ideas for projects (and some resources to carry them out) together with additional resources, be they human or material.

We list below the members of the committee and how you can get in touch with them. If you have a good project of joint research, conferences, publications, etc., which some of the membership of the American Mathematical Society could help along a bit, please let one of us know.

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Herb Clemens

Notice of Deaths of Two Society Staff Members

In the past year, two longtime employees of the Society who were known to many AMS members passed away.

Lev Liefman, a Russian translations editor for the Society, died on February 9, 1989. Dr. Liefman, a native Russian, studied mathematics at Kiev University and received his Ph.D. in 1962 from Moscow University. After spending more than a decade at Novosibirsk University and at the Siberian Branch of the Soviet Academy of Sciences, he and his family emigrated to Israel, where he took a position in the mathematics department at Haifa University. When the family emigrated to the U.S. in 1979, Dr. Liefman took the AMS position, which he held until his death.

Dorothy (Smith) Peckham, well-known to many members as the assistant director for AMS meetings, died on August 30, 1989 at the age of 63. Born in Warwick, Rhode Island, Mrs. Peckham (or "Dottie," as she was known) worked at the AMS for fourteen years. Starting in the Meetings Department in 1973 as departmental secretary, she later served as the assistant to Hope Daly, director of Meetings. For many years, Dottie organized the Summer Institutes and the Symposia on Pure and Applied Mathematics and worked closely with the AMS Associate Secretaries on sectional meetings. She was a permanent fixture at the transparency desk in the registration area during the national meetings. While many members will recall Dottie's meticulous organizational skills, most who knew her will remember the parties she orchestrated and the liveliness she brought to them. Her zest for life and work made her a favorite among the staff and the membership.

Washington Outlook

This month's column is written by Hans J. Oser, who is a consultant to the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics in Washington, D.C.

The Bush administration sent its first budget proposal to Congress on January 29. Even though President Bush was in office last year, the 1990 budget was of course the handiwork of the outgoing Reagan administration. The submission of the President's budget to Congress is only the opening salvo in a battle that will be fought with great seriousness over the next 8 months. It is well known that the interest in this annual ritual drops exponentially with the distance from the beltway around Washington. But there are moments when the process is sensitive to critical inputs that can materially alter the outcome. That is why the Office of Governmental and Public Affairs (OGPA) is here to monitor the hearings and the policy statements from the White House, departments, and independent agencies. Only by keeping a close watch over the events can we alert the mathematics community to take action when necessary in the form of testimony on the Hill and direct contact with the policy makers, in person or by mail. That is one of the functions for which the OGPA was created.

Science and Technology in the President's Budget for 1991

According to D. Allan Bromley, civilian R&D will receive a 12% increase, from \$23.8 billion to \$26.7 billion. (In this presentation the baseline for FY 1990 is the congressionally enacted budget for FY 1990, not what the Reagan administration asked for last year). Defense R&D will increase by 4%, from \$39.9 billion to \$41.4 billion. If these figures hold up, the civilian share of total R&D will actually increase from 37.4% to 39.2%, certainly a welcome step.

The basic research part of the R&D budget would increase by 8%, from about \$11.5 billion to \$12.4 billion. This is about 17% of the total R&D budget. Civilian basic

research would go up 9% under the President's proposal and defense basic research about 6% (while the overall defense budget is supposed to rise only 1%). Needless to say, this is the area where Congress will spend most of its time arguing over the "peace dividend", real or imaginary.

Total R&D, civilian and defense, would rise to \$68.1 billion. The President proposes another \$3.6 billion for the construction, repair and modernization of R&D facilities. On top of this, the Administration is committed to doubling the NSF budget by 1993 from the 1987 base year.

The President plans for substantial increases in the following programs (among others):

* **Science, mathematics, and engineering education** +26%, from \$841 million to \$1.06 billion, distributed over NSF, Department of Education, Department of Energy, NASA, and the National Institutes of Health. Emphasis is on "revitalization of mathematics, science and engineering education to produce the technological workforce and scientifically literate population needed to maintain a globally competitive economy".

* **Global Change:** +57% to over \$1 billion to support the interagency U.S. Global Change Research Program. This involves eight different departments and/or agencies that include National Oceanographic and Atmospheric Administration, Department of Interior, and the NSF, to name just the three that represent almost 75% of the total program.

* **Exploration beyond the Earth** will be strengthened by a new initiative to develop the new technologies needed for future manned exploration of the Moon and Mars. The 1991 budget calls for a nearly 50% increase to about \$1.27 billion in programs in NASA, Department of Energy and the Department of Defense.

National Science Foundation Budget Request for FY 1991

The Bush administration proposes to increase the NSF budget from \$2.08 billion to \$2.38 billion, or by 14% in FY 1991. While announcing his proposed budget

NSF director Erich Bloch said "Today education and research are critical to the country's economic security," and "our strategy emphasizes support of the core disciplines and research facilities, and a large investment in human resource development through education and research initiation. These investments are the cornerstone of increased national productivity and economic competitiveness."

The NSF strategy is to strengthen the research base and improve academic research equipment and facilities. A total of \$1.81 billion would be spent for this purpose, up 11% over the current year. For development of human resources, broadening participation and improving science and engineering education at all levels, NSF would spend \$463 million next year, an increase of 30% over the FY 1990 plan.

Increases in the NSF research and facilities budget (which comprises over 70% of the total) are planned for:
* Presidential Global Change Program: +100% to \$103 million

* Mapping and sequencing the plant genome.

* Funding a second class of 10-12 science and technology centers, that were deferred from FY 1990 because of budget constraints.

* Support of world-class facilities in astronomy and gravitational wave detection.

The following is how the Directorate for Mathematical and Physical Sciences allocated its research funds for three successive fiscal years:

Mathematical and Physical Sciences Directorate at NSF (\$1000's)

	1989	1990#	1991#
Mathematical Sciences	66,019	69,118 (4.7)	73,720 (6.7)
Astronomical Sciences	89,224	91,647 (2.7)	100,700 (9.9)
Physics	122,284	123,831 (1.3)	130,230 (5.2)
Chemistry	96,745	97,945 (1.2)	103,350 (5.5)
Materials Research	115,084	116,939 (1.6)	123,460 (5.6)
Science & Tech. Ctrs.	13,947	14,536 (0.3)	27,040 (86)
Major Research Equipment	500	42,990 -	63,000 (47)

Numbers in parentheses indicate the percentage increase over the prior year.



American Mathematical Society

Manager Russian Translation Program Position Open

The Society is seeking applications from individuals with a broad-based background in mathematics and fluent Russian. Publishing experience or participation in a translation program would be helpful.

The manager will be expected to provide long-range planning for the translation program. Responsibilities will include identifying and developing real or potential projects and authors, acting as liaison between consultants and the Translation Editorial Committee, serving as the interface between the Society and appropriate Soviet agencies and publishing houses, and directing the activities of the translations editorial staff.

The person selected will work in the Society's Providence Office. Travel to the Soviet Union will be necessary.

Applications should be sent to:

Director of Publication
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

The Society is an equal opportunity employer and has a generous fringe-benefit program including TIAA/CREF.

News and Announcements

Mark Grigorievich Krein 1907-1989

One of the most eminent mathematicians of our time, Mark Grigorievich Krein, passed away on October 17, 1989. He is the author of more than 270 papers and monographs of unsurpassed breadth and quality. His work opened up new areas of mathematics and greatly enriched the more traditional ones. He educated dozens of brilliant students in the USSR and inspired the work of many mathematicians, engineers and physicists all over the world.

In 1982 M. G. Krein was awarded the prestigious international Wolf Prize in Mathematics in Jerusalem. The citation to this prize reads in part as follows: "His work is the culmination of the noble line of research begun by Chebyshev, Stieltjes, S. Bernstein and Markov and continued by F. Riesz, Banach and Szego. Krein brought the full force of mathematical analysis to bear on problems of function theory, operator theory, probability and mathematical physics. His contributions led to important developments in the applications of mathematics to different fields ranging from theoretical mechanics to electrical engineering. His style in mathematics and his personal leadership and integrity have set standards of excellence."

Among his honorary awards, he was elected: corresponding member of the Ukrainian Academy, 1939; honorary member of the American Academy of Arts and Sciences, 1968; Foreign Member of the National

Academy of Sciences of the United States of America, 1979. Recently he was awarded the N. M. Krylov Prize of the Ukrainian Academy of Sciences.

Mark G. Krein was born on April 3, 1907, in Kiev into a Jewish family of modest means. His father was a lumber merchant. From early on he showed a talent for mathematics. At the age of 14 he already attended research seminars. He never got his undergraduate degree. In 1924 he ran away from home to Odessa and in 1926 he was accepted for his doctoral studies by N. G. Chebotarev at Odessa University. He completed his studies in 1929.

An excellent and enthusiastic teacher, he attracted many students. In the thirties he created one of the strongest centers of functional analysis throughout the world at Odessa University. His interests included geometry of Banach spaces, moment problems, integral equations and matrices, spectral theory of linear operators, extension problems and applications. Many of his results from this period, as well as joint results together with his friends and colleagues (N. I. Achiezer, F. R. Gantmacher), and his outstanding students (A. B. Artemenko, M. S. Livsic, D. P. Milman, M. A. Naimark, V. P. Potapov, M. A. Rutman, V. L. Shmuljan) are now characterized as classical and appear in all textbooks on functional analysis.

During World War II, from 1941 to 1944, he held the chair of theoretical mechanics at the Kuibyshev

(on the Volga) Industrial Institute. In 1944 he returned to Odessa but was soon dismissed from the University. This was the end of the famous center of functional analysis at Odessa University. From 1944 to 1952, M. G. Krein held a part time position as head of the department of functional analysis and algebra at the Mathematical Institute of the Ukrainian Academy of Science in Kiev. He was dismissed from this post in 1952. The official reason given was that he was not a permanent resident of Kiev. From 1944 to 1954 he held the chair of theoretical mechanics at the Odessa Marine Engineering Institute and from 1954 till his retirement he held the chair of theoretical mechanics at the Odessa Civil Engineering Institute. During the last few years of his life he was a consultant to the Institute of Physical Chemistry of the Ukrainian Academy of Sciences in Odessa.

A list of themes where M. G. Krein's research was fundamental and in many cases even determining the future of the field, includes: oscillating (totally positive) kernel functions and matrices; problem of moments, orthogonal polynomials, approximation theory; cones and singular convex sets in Banach spaces; theory of gaps and spaces with norms; the extension theory of operators, Hermitian-positive functions and helical arcs; integral operator string problems and method of projecting functionals; stability theory for differential equations; Weyl, Hopf, Toeplitz and singular integral

operators; scattering theory and inverse spectral problems; operator theory in spaces with an indefinite metric; indefinite extension problems; nonselfadjoint operators; triangular models; perturbation, interpolation and factorization theories; problems in elasticity theory, and ship waves and water resistance.

A profound intrinsic unity and a close interlacing of general abstract and geometric ideas with concrete and analytical results and applications are characteristic of Krein's work.

Krein was a very fine pedagogue and lecturer. He would always share his new ideas and plans with his students and colleagues. He was known for his scientific generosity and enthusiasm, as well as his kindness and attention to young mathematicians. The author of these lines was very privileged to have, during many years, such a teacher, coauthor and friend. He will always remember M. G. Krein with gratitude, affection and admiration.

In general, M. G. Krein was a fair, very amiable and kind person. However, all of his life he battled against mediocrity. After the Second World War he had to contend with hostile elements which fought fiercely against him using the officially supported antisemitism which was rife in the Ukraine, and especially so in Odessa. He was accused of Jewish nationalism, presumably for having had too many Jewish students before the War. This accusation was certainly included in his classified file and was held against him all of his life. Presumably, it played a significant role in his two dismissals which were mentioned earlier. He was not allowed to have Jewish students and was deprived of a university base. All attempts on the part of various societies and individuals in the Soviet Union to gain for him some measure of the official recognition which he so richly deserved, were unsuccessful. Worse than that, there were times when his friends feared that he

was in serious danger of arrest.

M. G. Krein liked to tell stories and jokes, some of which he invented himself. At one time he went to the rector of his institute and asked if there was any danger that he could be accused of Armenian nationalism since he had four graduate students who were Armenians. The rector did not understand the joke and tried, in all seriousness, to explain that in this case there was no danger.

M. G. Krein responded to his hostile surroundings in the only way open to him, by deep research and hard work. He and many of his students were protected by virtue of his outstanding achievements. In retrospect, it seems clear that he won this very difficult struggle. Firstly, he was able to devote all his life to mathematics (teaching and research), the work he loved so much. Secondly, he was able to spend most of his life in Odessa, a town which he had always regarded with love and affection (some of his friends thought that his life would have been much easier in Moscow or Leningrad). Thirdly, he was always the leader of a strong and dedicated group of colleagues and followers who loved and respected him. (This group existed almost on a private basis, holding many of its meetings in his house, or at the Scientists Club.) Fourthly, he had a great impact on the development of mathematics and its applications throughout the world. Even though he was never allowed to travel abroad, his brilliant work knew no borders.

This fight took a heavy toll on his health, and towards the end of his life he suffered from depression. This condition worsened after the tragic loss within one year of his wife, Rachel, and his only grandson, Aleosh. M. G. Krein died in Odessa (USSR) where he is buried. He is survived by his daughter, Irma Krein (Kozdoba), and a great-grandson, Mark Kozdoba.

Israel Gohberg
Tel-Aviv University

Morris H. DeGroot 1931-1989

Morris DeGroot, University Professor of Statistics and Industrial Administration at Carnegie-Mellon University, died on November 2, 1989. He was the leading national figure in Bayesian statistics, and had a profound influence on the development of the discipline.

Morrie worked in a wide variety of areas within Bayesian statistics, but is most identified with the area of rational decision-making under uncertainty. He was an originator, often opening up entirely new avenues of research. He wrote three books, edited four volumes, and authored over one hundred papers. In addition to fundamental work in statistics itself, these included works with economists and other social scientists in a wide variety of disciplines. From many such I have heard that Morrie was the best collaborator they ever had; his brilliance and personality made working with him a joy.

Research was but one of the ways in which Morrie profoundly influenced statistics. His textbook *Optimal Statistical Decisions* is one of the great books in the field. Morrie worked extensively on editorial boards, his two most influential stints being his editorship of the *Journal of the American Statistical Association* from 1971 to 1978, and his role from 1984-1988 as founder and first Executive Editor of the highly acclaimed journal *Statistical Science*. Morrie was also extremely active in professional societies and in governmental (National Institute of Health and National Research Council) advisory committees; his wisdom and guidance were sought by all.

Morrie was born on June 8, 1931 in Scranton, Pennsylvania. He graduated from Roosevelt University in 1952 with a B.S. in mathematics, and received a Ph.D. in statistics from the University of Chicago in 1958. He spent his academic career at Carnegie-Mellon University, serving as founding Head of the Depart-

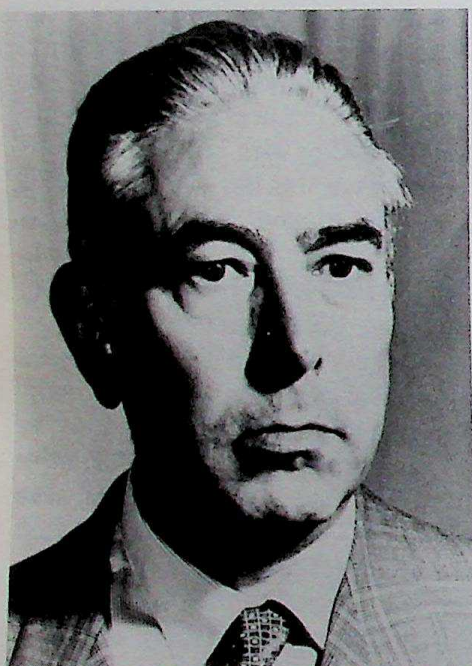
ment of Statistics in 1966. In 1984 he was named University Professor.

Morrie's brilliance and creativity existed in concert with exceptional warmth and good humor. He not only led scientifically, but was the source of personal inspiration for many. His work and his personality will remain inextricably woven into the fabric of statistics.

James Berger
Purdue University

1990 Wolf Prizes

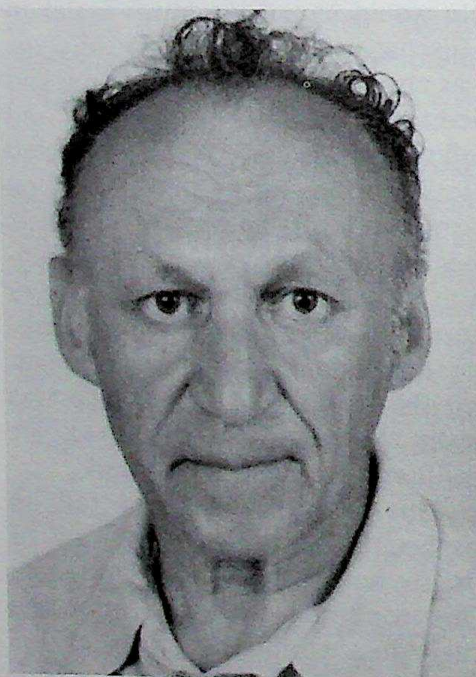
The 1990 Wolf Foundation Prize in mathematics will be shared by Ennio De Giorgi and Ilya Piatetski-Shapiro. The \$100,000 prize will be presented to the winners in May 1990 by President Chaim Herzog at the Knesset (Parliament) in Israel.



Ennio De Giorgi

Professor De Giorgi was cited for his "innovating ideas and fundamental achievements in partial differential equations and calculus of variations." Professor De Giorgi was born in Italy in 1928 and received his degree in mathematics from the University of Rome in 1950. Since 1959 he has been Professor of Algebraic and Infinitesimal Mathematical Analysis at the Scuola Normale Superiore di Pisa.

Professor De Giorgi's work is among the most important and creative accomplishments in the theory of partial differential equations and the calculus of variations. At the time he began his studies, mathematicians were unable to handle anything beyond second-order nonlinear elliptic equations in two variables. His first major breakthrough came in 1957, when he proved that measurable coefficients were Holder continuous. Perhaps his greatest contribution was his 1960 regularity theory for minimal hypersurfaces. These arise as surfaces of smallest area spanning a given boundary. The proof required Professor De Giorgi to develop his own version of what we now call geometric measure theory, along with a related key compactness theorem. He was then able to conclude that a minimal hypersurface is analytic outside a closed subset of codimension at least two. Since then, he and his school have settled many of the outstanding problems in this area.



Ilya Piatetski-Shapiro

Professor Piatetski-Shapiro was cited for his "fundamental contributions to the fields of homogeneous complex domains, discrete groups, representation theory and automorphic forms." Born in the U.S.S.R. in 1929, Professor Piatetski-Shapiro

received his Ph.D. in mathematics from the Moscow Pedagogical Institute and his Doctor of Science in 1959 from the Steklov Mathematical Institute. He currently holds joint positions as professor of mathematics at Tel Aviv University and Yeshiva University.

For almost forty years, Professor Piatetski-Shapiro has been making major contributions to mathematics by solving outstanding open problems and by introducing new ideas in the theory of automorphic functions and its connections with number theory, algebraic geometry, and infinite-dimensional representations of Lie groups. His work has been a major and often decisive factor in the great progress this theory has seen in the last three decades.

Among Professor Piatetski-Shapiro's main achievements are: the solution of Salem's problem about the uniqueness of the expansion of a function into a trigonometric series; the example of a nonsymmetric homogeneous domain in dimension four answering Cartan's question and the complete classification (with E. Vinberg and G. Gindikin) of all bounded homogeneous domains; the solution of Torelli's problem for K-3 surfaces (with I. Shafarevich); and a solution of a special case of Selberg's conjecture on unipotent elements, which paved the way for important advances in the theory of discrete groups. In addition, he proved many results in the theory of automorphic functions, such as the extension of the theory to the general context of semi-simple Lie groups (with I. M. Gel'fand), the general theory of arithmetic groups operating on bounded symmetric domains, the first "converse theorem" for GL₂, the construction of L-functions for automorphic representations for all the classical groups (with S. Rallis) and the proof of the existence of nonarithmetic lattices in hyperbolic spaces of arbitrarily large dimensions (with M. Gromov).

Mathematicians Honored in Germany

Alexander Mielke of Stuttgart University has been named as the first recipient of the Richard von Mises Award of the Gesellschaft für Angewandte Mathematik und Mechanik. The award of DM 2,500 is in recognition of Mielke's solution of the Saint-Venant problem (Saint-Venant's Problem and Semi-Inverse Solutions in Nonlinear Elasticity, *Archive for Rational Mechanics and Analysis*).

Winners in the area of applied mathematics of the Heinz Maier Leibnitz Award (DM 6,000 - DM 12,000 to facilitate recognition of young researchers and encourage further scientific work) were: ROLAND FREUND of Würzburg University for his work "On a Class of Chebyshev Approximation Problem which Arise in Connection with a Conjugate Gradient Type Method"; ENNO MAMMEN of Heidelberg University for his work "Asymptotics with Increasing Dimension for Robust Regression with Applications to the Bootstrap"; ALEXANDER MIELKE of Stuttgart University for his work "Saint-Venant's Problem and Semi-Inverse Solutions in Nonlinear Elasticity"; TOBIAS VON PETERSDORFF of Technische Hochschule for his work "Boundary Integral Equations for Mixed Dirichlet, Neumann and Transmission Problems"; MICHAEL RÖCKNER of the University of Edinburgh for his work "Traces of Harmonic Functions and a New Path Space for the Free Quantum Field"; and GABRIEL WITTUM of Heidelberg University for his work "Multi-Grid Methods for Stokes and Navier-Stokes Equations - Transforming Smoothers: Algorithms and Numerical Results."

Graduate Student Fulbrights

The United States Information Agency and the Institute of International Education have announced the names of U.S. graduate students who have received Fulbright awards for 1989-1990. Those receiving awards in mathematics are listed below, together

with their home institutions and the countries in which they will study.

Apparna Bhattacharya, University of California at Davis, West Germany; Lynn Fryberger, St. Olaf College, Hungary; Laura Green, Clemson University, West Germany.

1989 Autumn Prize of the Mathematical Society of Japan Awarded

The Autumn Prize of the Mathematical Society of Japan in 1989 was awarded to Shinzo Watanabe, Professor of Kyoto University, for his outstanding contribution to Stochastic Analysis.

1990 URI Awards Announced

The Department of Defense (DOD) has announced the 1990 awards in its University Research Initiative (URI) Program. The Air Force Office of Scientific Research (AFOSR) and the Defense Advanced Research Projects Agency (DARPA) were the two DOD agencies that made URI awards in the mathematical sciences.

The URI program was begun in 1986 as a way to enable universities to strengthen their ability to conduct basic research in areas important to national defense. One purpose of the URI program is to stimulate interdisciplinary, collaborative research, so the URI grants typically provide support for workshops, visitors, postdoctoral researchers, and graduate students. Individuals interested in these activities should contact the URI principal investigators directly.

The Directorate for Mathematical Sciences at AFOSR made five, three-year URI awards, out of a total of forty proposals submitted. The names of the principal investigators, their affiliations, the titles of their projects, and the sizes of the grants are listed below. The amounts stated will be given each year for three years.

H. THOMAS BANKS; University of Southern California; Modeling, estimation, and control of distributed parameter systems; \$400,000. ALAN

C. NEWELL; University of Arizona; Nonlinear optics and turbulence; \$500,000. ROBERT V. KOHN; New York University; Center for analysis of heterogeneous and nonlinear data; \$500,000. DAVID KUCK; University of Illinois, Urbana-Champaign; An integrated environment for the development of scientific and engineering applications; \$600,000. P. S. KRISHNAPRASAD; University of Maryland; Control of complex multibody spacecraft; \$400,000.

In an effort to distribute DOD research and development funds more broadly, Congress instructed the DOD to use part of the URI funds to make grants to schools whose total R&D funds from DOD fall below \$4 million. In fiscal year 1989, AFOSR's mathematics directorate made nine such awards (see *Notices*, October 1989, page 1004). This year, the Applied and Computational Mathematics Program at DARPA made five such awards in the area of wavelet theory and its applications. Each year for the three years, a total of \$1.25 million will go to support six grants.

The names of the DARPA/URI principal investigators and their institution, are: CHING-CHUNG LI, University of Pittsburgh; WOŁODYMYR R. MADYCH, University of Connecticut; REESE T. PROSSER, Dartmouth College; GUIDO L. WEISS, Washington University; GRANT V. WELLAND, University of Missouri at St. Louis; and R. O. WELLS, JR., Rice University.

Instrumentation Awards Announced

The National Science Foundation (NSF) has announced awards in its Undergraduate Instrumentation and Laboratory Improvement (ILI) program. The awards were made to community colleges, four-year colleges, and doctoral universities across the nation.

The proposals are evaluated and funded collaboratively by the NSF's Division of Undergraduate Science, Engineering, and Mathematics Edu-

cation and by the NSF's research directorates. The awards encompass a wide range of science and engineering disciplines.

Below are listed the principal investigators and their institutions for the awards in the mathematical sciences. The list includes awards made fiscal 1989 and some from fiscal 1990.

B. BRADEN, Northern Kentucky University; J. W. BURGMEIER, University of Vermont; J. CALLAHAN, Smith College; W. D. CURTIS, Kansas State University; R. L. DEVANEY, Boston University; E. L. DUBINSKY, Purdue University; J. A. FEROE, Vassar College; ULF GRENANDER, Brown University; M. HOFT, University of Michigan, Dearborn; A. L. HUDSON, Armstrong State College; J. F. HURLEY, University of Connecticut, Storrs; M. B. JACKSON, Earlham College; D. J. JOHN, Wake Forest University; P. T. JUDSON, Trinity University; W. J. KAMMERER, Georgia Institute of Technology; W. H. KRAUS, Wittenberg University; D. R. LATORRE, Clemson University; D. LOVELOCK, University of Arizona, Tucson; J. C. MATHEWS, Iowa State University of Science and Technology; L. D. MEEKER, University of New Hampshire; J. R. MICHEL, Marietta College; L. C. MOORE, Duke University; D. B. O'SHEA, Mount Holyoke College; H. C. PINKHAM, Columbia University; G. E. RUBIN, Marshall University Foundation, Inc.; B. TRAVIS, University of Texas at San Antonio; A. J. SCHAEFFER, Eastern Illinois University; D. H. SCHULTZ, University of Wisconsin, Milwaukee; D. D. SCHWARTZ, Ithaca College; T. S. SHORES, University of Nebraska, Lincoln; A. H. SHUCHAT, Wellesley College; D. C. SLOUGHTER, Furman University; D. B. SMALL, Colby College; J. R. SMART, University of Wisconsin, Madison; P. N. SOMERVILLE, University of Central Florida; K. D. STROYAN, University of Iowa; D. P. SUMNER, University of South Carolina at Columbia; G. J. WITT, Glendale Community College;

J. E. WHITE, Kenyon College; B. J. WINKEL, Rose-Hulman Institute of Technology; W. ZIMMERMAN, University of the Pacific.

The deadline for the next ILI competition will probably be in mid-November, 1990. Gerald Chachere of the Division of Mathematical Sciences handles proposals from Ph.D.-granting institutions; he can be reached at 202-357-3453 or via electronic mail, gchachere@nsf.gov (Internet) or gchachere@nsf (Bitnet). Spud Bradley, program director for calculus curriculum development in the Division of Undergraduate Science, Engineering, and Mathematics Education, handles proposals for all other institutions; he can be reached at 202-357-7051 or via electronic mail, sbradley@nsf.gov (Internet) or sbradley@nsf (Bitnet). The street address is National Science Foundation, 1800 G Street, NW, Washington, DC 20550.

MAA Prizes Presented in Louisville

The Mathematical Association of America (MAA) presented a number of prizes during the Joint Mathematics Meetings in Louisville, Kentucky in January.

The Award for Distinguished Service, consisting of \$4000 and a certificate, is made for outstanding service to mathematics through activities that significantly influence the field of mathematics or mathematics education on a national scale. The Chauvenet Prize of \$500 and a certificate recognizes a noteworthy mathematics paper which would make interesting and profitable reading for all MAA members.

LEON HENKIN of the University of California at Berkeley received the 1990 Award for Distinguished Service. A former president of the Association for Symbolic Logic, Professor Henkin has an outstanding record of scholarly work in his field of logic and the foundations of mathematics. He has also found the time

and energy to make a variety of contributions to the improvement of mathematical instruction at the pre-college and college levels, particularly in the area of encouraging minority students. For example, last year he helped to organize a six-week tutorial program funded by the Sloan Foundation to encourage mathematically talented women and minority undergraduates to pursue careers requiring the mathematics doctorate. In addition to serving as an advisor to graduate students in mathematics, he has had five doctoral students over the last twenty years in an interdisciplinary program in mathematics and science education. His founding twenty years ago of the Mathematics Opportunity Committee in the Berkeley mathematics department has helped to increase the number of women and minorities receiving mathematics Ph.D.s. Also well known as an excellent expositor of mathematics (as a writer and lecturer), Professor Henkin received the 1964 MAA Chauvenet Prize. He was born in Brooklyn, New York in 1921 and received his Ph.D. in 1947 from Princeton University.

DAVID HOFFMAN of the University of Massachusetts at Amherst received the 1990 Chauvenet Prize for his article, "The Computer-Aided Discovery of New Embedded Minimal Surfaces" (*The Mathematical Intelligencer*, volume 9, 1987, pages 8-19). The article presented a multifaceted description of recent progress in the theory of minimal surfaces. The role of the computer in the discovery of new complete minimal surfaces of finite total curvature in R^3 gives this story a fascinating new twist. The excellence of the exposition and the many computer-generated illustrations (some in color) combined to produce a marvelous article of interest to the mathematical community. Born in 1944 in Far Rockaway, New York, Professor Hoffman received his Ph.D. in 1972 from Stanford University.

MSEB Issue Two Reports

The Mathematical Sciences Education Board (MSEB) of the National Research Council has issued two reports on improving mathematics teaching and learning in the U.S. Taken together, the reports cover two important aspects of the mathematics education reform effort: the impetus and support coming from business and industry, and the intellectual groundwork needed to rethink the mathematics curriculum.

The first report, "Mathematics Education: Wellspring of U.S. Industrial Strength," represents the proceedings of a symposium held in December, 1988. The symposium brought together representatives from business, industry, government, and education to discuss shared concerns about the quantitative and problem-solving skills of the work force. "The rudimentary skills that satisfied the needs of the workplace in the past no longer suffice," says the 20-page report, noting that today's workers need to be able to work with data and computers, solve problems and make estimates, and collaborate and communicate with other workers. Peppered with quotes from the participants, the report describes some of the problems and outlines means for change.

The other report, entitled "Reshaping School Mathematics: A Philosophy and Framework for Curriculum," is a more ambitious document. The 60-page report proposes a framework for reform of school mathematics by means of changes central to the curriculum. Two issues are perspectives on the need for mathematics, the nature of mathematics, and the learning of mathematics; and the changing roles of calculators and computers in the practice of mathematics. Ideas for reform are outlined in both what is taught and how it is taught; the focus is on curricular change, but the report also addresses teacher education, assessment, and instructional materials.

The report is not intended to detail the specifics of an ideal curriculum, but rather to lay out goals and principles as the groundwork for the formulation of new curricula. Stating that "Foundations for an improved mathematics curriculum must rest on analysis of the nature of mathematics and the goals of mathematics education," the report describes some aspects of the nature of the subject, as well as principles of education, that must guide curricular reform. Illustrated with pictures and enlivened with a number of examples of mathematical problems, the report is required reading for those with a stake in improving mathematics education.

Copies of the "Wellspring" report are available free of charge by calling the MSEB office at 202-334-3294, or writing to them at 818 Connecticut Avenue, NW, Suite 500, Washington, DC 20006.

"Reshaping School Mathematics" is available from National Academy Press for \$7.95. There is a 15% discount for 5-24 copies and a 25% discount for 25-499 copies. All orders must be prepaid, and there is a \$2.00 fee for shipping and handling. To order by phone using a credit card, call toll-free, 1-800-624-6242, Monday through Friday, 8:30-5 (ET). The mailing address is National Academy Press, 2101 Constitution Avenue, NW, Washington, DC 20418.

NSF's Fiscal 1990 Budget

Due to budgetary pressures, the National Science Foundation (NSF) has foregone plans for a new round of Science and Technology Centers for the current fiscal year. And, because of a Gramm-Rudman sequester and other across-the-board reductions that affected a number of government agencies, all increments planned for continuing NSF grants and cooperative agreements will be reduced by 2%. The steps were taken as the NSF formulated its spending plan after receiving its

fiscal year 1990 budget appropriation from Congress in December.

Compared to other areas in the NSF's Mathematical and Physical Sciences directorate, the Division of Mathematical Sciences (DMS) fared well, with a 5% increase; overall, the directorate received an increase of about 3%. The 12% increase for the directorate for Computer and Information Science and Engineering will be used primarily for the NSF supercomputing centers and networking. Overall, NSF's research activities received only a 6% increase over the fiscal 1989 level, a far cry from the original requested increase of about 14%.

Funds originally intended for the Science and Technology Centers will be used to ease tight funding in certain research divisions and also to allow for an increase of around 11% for the existing Centers which were funded last year. The current batch of Centers proposals are to be evaluated this Spring and funded out of the fiscal 1991 budget.

The 2% reduction will take a bite out of the yearly increments the NSF makes on continuing grants to offset inflation, which was around 4% last year. Within the DMS, all budget categories on such grants will be scaled back by 2%, but grantees will be encouraged, to the extent that they can, to restore the original amounts intended for student support. However, the Division will not decrease its total allocation for support of graduate students. Certain NSF programs, such as the graduate fellowships, will be protected from the 2% reduction.

In a notice to colleges, universities, and other organizations, NSF Director Erich Bloch stated that the Foundation believes the 2% scaleback of increments on continuing grants "is the fairest way to ensure that the effect of the across-the-board [NSF budget] reductions is shared equitably among new and prior grantees. The budget amounts freed up will remain with the programs, divisions,

and directorates that funded the original awards and will be used to ease the disproportionate impact on new and renewal proposals in those fields."

Congress again boosted the budget of Science and Engineering Education (SEE) above the level the NSF had requested, providing a 19% increase. Within the SEE directorate, funding for the calculus curriculum development program will remain level. However, a significant portion of the DMS increase for fiscal 1990 will go toward funding new calculus curriculum development projects, increasing the total funding for this activity by 25-35%. This year, the NSF will also begin supporting curriculum development projects in other undergraduate courses (see *Notices*, February 1990, page 145).

In addition, the appropriations legislation for the NSF's fiscal 1990 budget reinstates the salary cap instituted last year. This rule stipulates that no individual may receive salary reimbursement on any NSF grant at a rate that exceeds the equivalent of \$95,000 per year.

Bush Names Science Council

In mid-February, President Bush named the members of the President's Council of Advisers on Science and Technology. The appointment of the Council represents a change from the Reagan Administration, which relied only on the Science Adviser and the Office of Science and Technology Policy. D. Allan Bromley, the President's Science Adviser, chairs the Council. The other members are: Norman E. Borlaug, Texas A&M University; Solomon J. Buchsbaum, AT&T Bell Laboratories; Charles L. Drake, Dartmouth College; Ralph E. Gomory, Sloan Foundation; Bernadine Healy, Research Institute of the Cleveland Clinic; Peter W. Likens, Lehigh University; Thomas E. Lovejoy, the Smithsonian Institution; Walter E. Massey, University of Chicago; John P. McTague, Ford Motor Company; Daniel Nathans, Johns Hop-

kins University Medical School; David Packard, Hewlett-Packard Company; Harold T. Shapiro, Princeton University.

News from the Mathematical Sciences Research Institute Berkeley, California

The Mathematical Sciences Research Institute (MSRI) Board of Trustees has voted to appoint Robert Osserman of Stanford University to a three year term as MSRI's Deputy Director, beginning September 1, 1990. He will succeed Emery Thomas, the present Deputy Director, who has held the post since April, 1987.

Events of 1989-1990

At the halfway point in the academic year a great deal of activity has already taken place in our two main programs - Logic and Algebraic Topology and its Applications. In October MSRI held a workshop on Set Theory and the Continuum (organized by H. Woodin), while in November two workshops took place: Homotopy Theory (organized by G. Carlsson) and one on Logic Related to Computer Science and Programming Language Theory (organized by Y. Moschovakis). Two events occurred in January, 1990: The Pacific Geometry Seminar met at MSRI January 13-14, while during the week of January 22-26 there was a workshop on Applications of Algebraic Topology to Geometry and Analysis (organized by R. Cohen and J. Jones). The period March 19-April 20 is a special month devoted to Number Theory and Algorithms, organized by H. Lenstra, with a workshop (with the same title) the week of March 26-29. In May (14-18), MSRI will host a workshop on K-Theory (organized by W. C. Hsiang and J. Jones). The final event of the year is a workshop on Model Theory, organized by E. Hrushovski, June 4-8, 1990.

Future Events

Future programs, presently in place are as follows:

1990-1991: Partial Differential Equations and Continuum Mechanics, Representations of Finite Groups (first half), Strings in Mathematics and Physics (second half).

1991-1992: Statistics, Lie Groups and Ergodic Theory, Mathematical Biology (Summer 1992).

1992-1993: Algebraic Geometry, Symbolic Dynamics (first half), Transcendence and Diophantine Problems (second half).

MSRI welcomes suggestions and proposals for future programs.

Applications are currently invited for 1991-1992. MSRI will offer postdoctoral fellowships and senior memberships; the deadline for applying is **November 30, 1990**. In addition, the program of research professorships will be repeated; this has the earlier deadline of **October 1, 1990**. Candidates are welcome in all areas of the mathematical sciences as well as in the main programs. Watch for detailed announcements in an advertisement in the *AMS Notices* and a widely distributed poster.

The MSRI Scientific Advisory Council recently appointed the following research professors for 1990-1991: Robert Friedman, Jerome Galstein, Corinne Manogue, Emma M. Viato, Robert Robson, Gilbert Strang. Offers are presently going out for postdoctoral fellowships and senior memberships for 1990-1991.

News from the Institute for Mathematics and its Applications University of Minnesota

The Institute for Mathematics and its Applications (IMA) is initiating its Summer Program for Graduate Students from the 19 IMA Participating Institutions. Each year the program will bring together for four weeks the summer, a select group of 30-40 students from the Participating Institutions. The students will live in a dormitory on one of the PI

puses; the location of the campus may change from year to year. During the four weeks, there will be a series of (related) lectures to be given by four senior mathematicians. The summer 1990 program is on Algebra and will be held July 2-27 at the University of Michigan, Ann Arbor. Melvin Hochster is the coordinator; the speakers are Craig Huneke, Hyman Bass, Charles Curtis and Philip Hanlon.

The 1989-1990 academic year program at the IMA is Dynamical Systems and their Applications. The early spring (March 19-April 13) portion of the program is a period of concentration on Mathematical Physiology and Differential-Delay Equations, organized by Michael Mackey, Jack Hale, Nancy Kopell, and John Mallet-Paret. The central theme is the effects of delays in biological dynamics. Following introductory expository talks by the organizers, overview talks of 2-3 hours each will be given on the weekly topics by William Brock and Doyne Farmer (Time Series Analysis and Chaotic Dynamics); Jeffrey Grinstein and Roger Traub (Genesis of Large Scale Collective Activity in Higher Order Neural Nets); Uwe an der Heiden and John Rinzel (Single Neuron Models and Small Neural Networks); and Scott Fraser and James Murray (Developmental Biology: Dynamics of Pattern Formation and Morphogenesis).

Based on the success of the symbol manipulation workshop offered last year, the IMA has added a special workshop to the spring schedule: Using Algebraic Processors in Dynamical Systems (April 16-20, 1990). The organizers are Ken Meyer and Peter Olver. The main purpose of this workshop is to introduce researchers in dynamical systems to the capabilities of automated algebraic processors like MACSYMA, MAPLE and other such systems. Several series of tutorial lectures and research lectures will teach the participants

about how specific algebraic processors work and how researchers have used these systems. Each participant will be given a computer account on one of the IMA's workstations with easy access to six computer algebra systems.

From mid-April to mid-June 1990 there will be a period of concentration on Fluid Flow and Convection Dynamics, organized by George F. Carnevale, Ciprian Foias, Raymond Pierrehumbert, Roger Temam, and David Yuen. Workshops during this period are Dynamical Theories of Turbulence in Fluid Flows (May 29-June 2, 1990); Nonlinear Phenomena in Atmospheric and Oceanic Sciences (June 4-8, 1990); and Chaotic Processes in the Geological Sciences (June 11-15, 1990). The last two are sponsored jointly with the Minnesota Supercomputer Institute.

The IMA will run two summer programs in 1990. The first of these is Radar and Sonar (June 18-29), organized by Alberto Grunbaum, Marvin Bernfeld, Richard E. Blahut and Richard Tolimieri. The first week will be run as a summer school with minicourses by Richard E. Blahut, Willard Miller, Jr., and C. H. Wilcox. During the second week scientists (from industry, universities and government agencies) who are working on Radar or Sonar will present research problems.

The other 1990 summer program is New Directions in Time Series Analysis (July 2-27), organized by Emanuel Parzen, David Brillinger, Murray Rosenblatt, Murad Taqqu, John Geweke and Peter E. Caines. The weekly topics are Non-Linear Models, Self-Similar Processes & Long Range Dependence, Interactions of Time Series & Statistics, and Time Series Research Common to Engineers & Economists.

For more details concerning the two summer programs, see the advertisements in the January 1990 *Notices*.

News from the Mathematical Sciences Institute Cornell University

The second of two summer workshops at the Mathematical Sciences Institute (MSI) will be Function Estimation and Statistical Applications, June 14-16, 1990. Organized by David Ruppert, Operations Research and Industrial Engineering, Cornell University and J. S. Marron, University of North Carolina, Chapel Hill, this workshop will focus on using data to estimate unknown functions. Much of statistics concerns the estimation of functions, such as conditional expectations (regression functions), probability densities, and hazard functions. In classical statistics, these functions are generally assumed to be known a priori, except for a finite number of real valued parameters which are estimated. Such assumptions are often unrealistic and can cause features of the data to be obscured because they do not exist in the assumed model.

This workshop is on modern statistical methods not relying on parametric assumptions. Nonparametric estimation of functions is based on locally averaging, for example, through splines, kernels, or estimation of coefficients in a series expansion. The degree of smoothing or local averaging is controlled by a "smoothing parameter." Although many nonparametric estimation methods for functions have been known for several decades and some, such as the histogram for much longer, the difficult problem of choosing the smoothing parameter has been addressed only recently. There now exist a variety of methods for data-based selection of a smoothing parameter, rather precise asymptotic descriptions of their behavior, and bounds on the convergence rate of any estimator of the optimal smoothing parameter. This is still an area of intense research activity, and the speakers at this workshop include

leaders in this field: N. Altman, R. J. Carroll, D. Cline, D. Cox, R. Eubank, P. Hall, I. Johnstone, R. Liu, J. S. Marron, D. Nychka, J. Rice, D. Scott, P. Speckman, and M. Wells.

Function estimation has close ties with other areas of mathematics including numerical, functional, and Fourier analysis and probabilistic limit theory.

This workshop will be held at Cornell University. For more information about the scientific content, contact David Ruppert, School of Operations Research and Industrial Engineering, Cornell University, 343A Upson Hall, Ithaca, NY 14853, 607-255-9136. davidr@orie.cornell.edu.

To register for the workshop, contact Valerie Styles, Mathematical Sciences Institute, Cornell University, 201 Caldwell Hall, Ithaca, NY 14853-2602, 607-255-7740.

MSI is sponsoring a major symposium on "Modern Perspectives of Mathematics: Mathematics as a Consumer Good, Mathematics in Academia," March 29-31, 1990, at Cornell University. See this column in the

November 1989 *Notices* for a full description. Registration packets are now available. Contact conference secretary Diana Drake at the MSI address listed above, phone number 607-255-7752.

The Fermat Prize for Research in Mathematics

The Fermat Prize will reward the research of mathematicians working in the areas in which the contributions of Pierre de Fermat have been significant: principles of variational theory, the foundations of the calculus of probabilities and of analytic geometry, and number theory. The list, however, is not restrictive; the spirit of the prize is rather to reward the results of research that is accessible to the greatest number of professional mathematicians.

The amount of 100,000 FF (U.S. \$17,500) has been designated by MATRA-Espace for the Fermat Prize, which will be awarded every other year in Toulouse. The second award will take place in the spring of 1991.

Application deadline is December 21, 1990. Further information such as the rules of the contest should be available by March 1991 from Prix Fermat de Recherche Mathématiques, Service des Relations Publiques, Université Paul Sabatier, 118 route de Narbonne, 31062 Toulouse Cédex, France.

Erratum

Postdoctoral Positions Research or Research/Teaching

In the December 1989 *Notices*, page 1454, it was reported that Memphis State University had 21 postdoctoral research or research/teaching positions available. The actual number of positions available is 2.

Errata to 1989 Index

The following are corrected entries for the 1989 Index to *Notices*, which appeared on page 1558 in the December issue.

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Acquisition Editor

Lance W. Small is serving as Acquisition Editor for the Society. He is available to assist potential authors in developing projects and referring book manuscripts to the appropriate editorial committee for final acceptance. Authors with manuscripts or publication proposals of various types including lecture notes, surveys, advanced research monographs, graduate level textbooks or books of general mathematical interest should contact Professor Small at the address below.

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AMS Reprint Series

Changes in tax laws have made it less profitable and sometimes even unprofitable for commercial publishers to keep books in print. As a result, some good books have been allowed to go out of print. The Society has established a reprint series as a service to the mathematical community. The Series will contain books of lasting interest and value. A Committee on Reprints of Books has been appointed to judge the suitability of available books for reprinting. Suggestions of books to be included should be sent to:

Mary Lane
Director of Publication
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

It would be helpful if a short description and information such as the original publisher were included.

Funding Information for the Mathematical Sciences

Proposals for the NSF's

Division of Mathematical Sciences

Research proposals submitted to the Division of Mathematical Sciences (DMS) of the National Science Foundation should be submitted six to nine months prior to the expected start date, to ensure timely notification of outcome. The DMS will accept such proposals at any time of the year. The program officers in the DMS are listed below:

Algebra and Number Theory	
Ann Boyle	202-357-3695
Jonathan Lubin	
Applied Mathematics	
Alfonso Castro	202-357-3686
Fred Howes	
Classical Analysis	
John Ryff	202-357-3455
Computational Mathematics	
Alvin Thaler	202-357-3691
Geometric Analysis	
Russell Walker	202-357-3451
Modern Analysis	
Ira Herbst	202-357-3697
Special Projects	
Deborah Lockhart	202-357-3453
Gerald Chachere	
Statistics and Probability	
Mary Ellen Bock	202-357-3693
Peter Arzberger	
Topology and Foundations	
Ralph Krause	202-357-3457

Program officers may be contacted via electronic mail. To form an individual's address, take the first initial and last name, and append @nsf.gov for Internet or @nsf for

BITNET. For example, to contact Ann Boyle via Internet, use the address aboyle@nsf.gov.

The street address for the DMS is National Science Foundation, Room 339, 1800 G Street, NW, Washington, DC 20550.

Access for Women, Minorities and the Disabled

Career Access Opportunities in Science and Technology for Women, Minorities, and the Disabled is a program of the National Science Foundation (NSF) which seeks to enhance opportunities for those groups that have historically been underrepresented in science and engineering. The program supports two kinds of activities.

Comprehensive Regional Centers for Minorities involve a systemic approach to increasing the minority presence in science and engineering. The projects are focused in regions of high minority population and are developed through partnerships among colleges and universities, school systems, state and local governments, business and industry, etc. The Centers are comprehensive in their coverage of science, mathematics, and engineering; in addressing all educational levels from elementary through graduate; and in emphasizing interaction among cooperating organizations.

Specific activities within the centers might include teacher workshops, faculty seminars, enrichment experiences for students at all lev-

els, materials development, conferences for parents and other interested members of the public, and regional networks. Because of the complexity and coordination involved in the Centers, a blend of development and implementation activities is quite appropriate for these projects. The Centers are intended to be long term efforts and should at the outset have significant contributions from non-NSF sources.

Model Undergraduate Projects for Women, Minorities, and the Disabled seek to encourage colleges, universities, and other organizations to design and create highly focused activities at the undergraduate level. With an emphasis on testing new ideas (rather than replicating proven programs), the projects design learning experiences in science and mathematics that will encourage entry or improve retention for underrepresented groups. In addition, this program supports regional workshops and national conferences.

The deadline for proposals for both activities is **April 2, 1990**. For more information, contact Theodore Reid, Program Director, Career Access Opportunities in Science and Technology for Women, Minorities, and the Disabled, Office of Undergraduate Science, Engineering, and Mathematics Education, Room 639, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-7051; electronic mail undergrad@note.nsf.gov (Internet) or undergrad@nsf (Bitnet).

For Your Information

Bucharest Library

The Society has received a letter from Dr. Ion Stoica, director of the Central University Library in Bucharest, Romania. In part, this letter says:

"At the end of 1989, the Central University Library in Bucharest passed through the historic events which resulted in the overthrowing of the Ceausescu dictatorship, suffering great losses in all categories of collections. Half a million volumes belonging to the most valuable collections were burnt by the fire caused by the terrorists.

There were destroyed special collections of inestimable value: manuscripts and correspondence signed by personalities of the universal culture, collections of unique photographs and documents, collections of microfilms and microfiches, etc. There were also destroyed library microfiche producing devices, such as printing machines, copying machines, typewriters, computers, etc. The building of the Central Library, a monument of architecture in Bucharest, was gravely damaged."

If you are interested in these problems or have information which could be of help to our Romanian colleagues, please contact the chairman of the AMS Committee on Service to Mathematicians in Third World Countries:

Professor Raymond Ayoub
Department of Mathematics
The Pennsylvania State University
University Park, PA 16802
email: RGA1@PSUVM.BITNET,

who will act as a coordinator of individual efforts in this matter.

Polish Mathematical Publications

The Society received a letter from Professor Stefan Rolewicz of the Mathematics Institute of the Polish Academy of Sciences. Professor Rolewicz stated that, as of January 1990, the Banach Center Publications and the following mathematical journals are published and distributed by the Institute:

Acta Arithmetica
Annales Polonici Mathematici
Applicationes Mathematicae (*Zastosowania Matematyczne*)
Colloquium Mathematicum
Dissertationes Mathematicae (*Rozprawy Matematyczne*)
Fundamenta Mathematicae, and
Studia Mathematica.

Professor Rolewicz wrote that he would appreciate publication of this information to help support the Polish mathematical community. Scientific research there has met with difficult times as a result of Polish economic instability, he said.

All inquiries concerning subscriptions, sale, exchange, etc., should be sent to Professor Rolewicz at the following address:

Mathematical Institute
ul. Śniadeckich 8
P. O. Box 137
PL-00-950 Warszawa
Poland

Telexes may be sent to Professor Rolewicz at number PL 816112.

1990 AMS Elections

Nominations by Petition

Vice-President or Member-at-Large

One position of vice-president and member of the Council ex officio for a term of two years is to be filled in the election of 1990. The Council intends to nominate two candidates, whose names may be expected to appear in the June issue of *Notices*, which is scheduled to be mailed by the printer on 23 May. Nominations by petition as described in the rules and procedures are acceptable.

Five positions of member-at-large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate seven candidates, whose names may be expected to appear in the June *Notices*. Nominations by petition in the manner described in the rules and procedures are acceptable. The Council has stated its intent to have at least ten candidates and will bring the number up to ten if the nominations by petition do not do so.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions.

Prior to presentation to the Council, petitions in aid of a candidate for the position of vice-president or of member-at-large of the Council must have at least 50 valid signatures and must conform to several rules and operational considerations, which are described below.

Editorial Boards Committee

Two places on the Editorial Boards Committee will be filled by election. There will be four continuing members of the Editorial Boards Committee, namely:

Linda Keen
Carlos Kenig

Barry Simon
Daniel Zelinsky

The new members will be elected in a preferential ballot. The President will name three candidates for these two places. The names may be expected to appear in the June issue of *Notices*. Nominations by petition, in the manner described in the rules and procedures, will be accepted. Should the final number of candidates be less than four, the President will bring it up to four.

The name of a candidate for member of the Editorial Boards Committee may be placed on the ballot by petition. The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

Nominating Committee

Three places on the Nominating Committee will be filled by election. There will be seven continuing members of the Nominating

Committee, namely:

Joan S. Birman
James E. Humphreys
Barbara Lee Keyfitz
Victor Klee

Ray A. Kunze
Alan D. Weinstein
Robert F. Williams

The new members will be elected in a preferential ballot. The President will name five candidates for these three places. The names may be expected to appear in the June issue of *Notices*. Nominations by petition, in the manner described in the rules and procedures, will be accepted. Should the final number of candidates be less than six, the President will bring it up to six.

The name of a candidate for member of the Nominating Committee may be placed on the ballot by petition. The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

Rules and Procedures

Use separate copies of the form for each candidate for vice-president, member-at-large, or member of the Nominating and Editorial Boards Committees.

1. To be considered, petitions must be addressed to Robert M. Fossum, Secretary, P.O. Box 6248, Providence, Rhode Island 02940, and must arrive by 6 July 1990.

2. The name of the candidate must be given as it appears in the *Combined Membership List*. If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the *Notices*. If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate's mailing label or the Providence office.

3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.

4. On the next page is a sample form for petitions. Copies may be obtained from the Secretary; however, petitioners may make and use photocopies or reasonable facsimiles.

5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.

6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the *Combined Membership List* and the mailing lists. No attempt will be made to match variants of names with the form of name in the CML. A name neither in the CML nor on the mailing lists is not that of a member. (Example: The name Robert M. Fossum is that of a member. The name R. Fossum appears not to be.)

7. When a petition meeting these various requirements appears, the Secretary will ask the candidate whether he is willing to have his name on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving his consent.

NOMINATION PETITION FOR 1990 ELECTION

The undersigned members of the American Mathematical Society propose the name of

as a candidate for the position of (check one):

- ☐ **Vice-President**
- ☐ **Member-at-Large of the Council**
- ☐ **Member of the Nominating Committee**
- ☐ **Member of the Editorial Boards Committee**

of the American Mathematical Society for a term beginning 1 January, 1991.

Name and Address (printed or typed)

Signature

Signature

Signature

Signature

Signature

Signature

University Park, Pennsylvania State University April 7-8

Program

The eight-hundred-and-fifty-seventh meeting of the American Mathematical Society will be held at the Pennsylvania State University in University Park, Pennsylvania, on Saturday, April 7, and Sunday, April 8, 1990. This meeting will be held in conjunction with a meeting of the Association for Symbolic Logic (ASL).

Invited Addresses

By invitation of the Eastern Section Program Committee, there will be four invited addresses. The speakers, their affiliations, the titles of their talks where available, and the scheduled times of presentation are:

ROBERT T. GLASSEY, Indiana University, *On collisionless plasmas and the Vlasov-Maxwell equations*, 11:00 a.m. Sunday.

KARSTEN GROVE, University of Maryland, College Park, *Geometry and topology of manifolds curved from below*, 1:30 p.m. Sunday.

LOWELL EDWIN JONES, State University of New York at Stony Brook, *Rigidity for non-positively curved manifolds*, 11:00 a.m. Saturday.

GANG TIAN, Princeton University, *Einstein metrics on algebraic manifolds*, 1:30 p.m. Saturday.

Special Sessions

By invitation of the same committee, there will be four special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Classical and quantum groups, RANEE KATHRYN BRYLINSKI, Pennsylvania State University.

Algebraic topology, DONALD M. DAVIS, Lehigh University.

Geometric topology, THOMAS FARRELL, Columbia University.

Recent progress on Einstein manifolds and related topics, GANG TIAN.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Late papers will not be accommodated.

Registration

The meeting registration desk will be located in the lobby of the Keller Conference Center. The registration fees are \$30 for members of the AMS or ASL, \$45 for nonmembers, and \$10 for students and unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

Activities of Other Organizations

The Pennsylvania Prognostic Testing Conference will be held on Friday, April 6, from 1:30 p.m. to 4:30 p.m. BERT K. WAITS, Ohio State University, will discuss the *Ohio Early Mathematics Placement Testing Program*. JOHN G. HARVEY, the University of Wisconsin, Madison, will briefly describe prognostic testing programs in the United States and discuss the effects of calculators on mathematics testing.

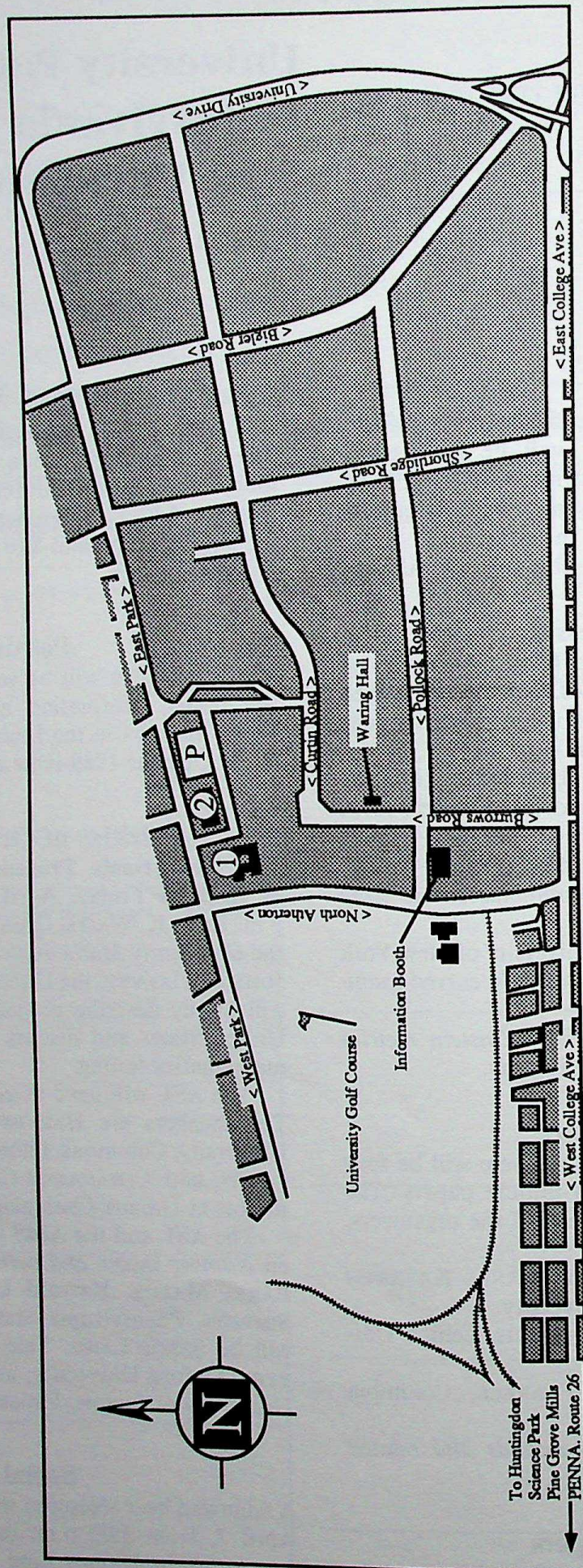
The ASL will have three invited one-hour addresses. The speakers are HARVEY M. FRIEDMAN, Ohio State University, Columbus; LEONARD LIPSCHITZ, Purdue University; and ATHANASIOS C. PHEIDAS, the University of Illinois at Urbana-Champaign.

The ASL and the AMS will co-sponsor a symposium on *Number theory and decidability* to be moderated by BARRY MAZUR, Harvard University, and STEPHEN G. SIMPSON, Pennsylvania State University. The panelists will be SERGE LANG, Yale University, ANGUS MACINTYRE, Oxford University, and LOU VAN DEN DRIES, the University of Illinois, Urbana.

Social Event

A wine and beer reception will be held Saturday evening, April 7, from 5:00 p.m. to 7:30 p.m. in the Fireside Lounge at the Nittany Lion Inn. The admission price is \$5 per person.

PENNSYLVANIA STATE UNIVERSITY



1 – Nittany Lion Inn 2 – Conference Center P – Parking

Accommodations

A block of rooms has been reserved at each of the following hotels/motels. The American Mathematical Society is not responsible for rate changes or accommodations offered by hotels/motels.

Nittany Lion Inn

North Atherton Street,
University Park, PA 16802
Telephone: 814-231-7500

Single \$58 Double \$68

Hampton Inn

1101 East College Avenue,
University Park, PA 16802
Telephone: 814-231-1590

Single \$46 Double \$50

Sheraton/Days Inn

240 South Street,
University Park, PA 16802
Telephone: 814-238-8454

Single \$53 Double \$63

Food Service

The Nittany Lion Inn, adjacent to the Keller Conference Center, has a full service restaurant offering breakfast, lunch, and dinner. Complete listings will be available at the meeting registration desk.

Travel

US Air/Allegheny Commuter Airlines serve the State College area through the University Park Airport located five miles from campus. Limousine or taxi service is available for all flights. For reservations and information on US Air/Allegheny Commuter, please call 814-238-8414 or 800-428-4253. By bus, Trailways and Greyhound Lines connections are available to and from State College. For Trailways information, please call 814-238-7362; for Greyhound information, please call 814-237-5865. If traveling by car, University Park is readily accessible from both ends of the state via Interstate 80 (I-80).

Parking

Parking is available on campus for a fee of \$2 on Monday through Friday. There is no parking fee on Saturday. Parking permits will be available at the registration desk located in the Keller Conference Center.



UNFOLDINGS AND BIFURCATIONS OF QUASI-PERIODIC TORI

H. W. Broer, B. Huitema, F. Takens, and B. L. J. Braaksma

(Memoirs of the AMS, Number 421)

In the theory of dynamical systems, the occurrence of equilibria and periodic motions, as well as their general persistence and stability properties, are now fairly well understood. Researchers also have some systematic insight into the role of external parameters. This book aims to mimic this classical theory in the case of quasi-periodic motions. These motions are most familiar in the context of the conservative dynamics of classical mechanics, but they also occur with dissipative dynamics—for example, quasi-periodic attractors play a role in the onset of turbulence.

In the first part of the book, the authors present a general treatment of the use of external parameters in various contexts, employing notions such as integrability and transversality. The second part, dealing only with dissipative cases, studies bifurcations when the hyperbolicity is mildly violated. Readers will appreciate the way the book systematically ties together a number of cases for quasi-periodicity and the resulting improvement of accuracy. In addition, a number of new applications are presented.

1980 *Mathematics Subject Classifications*: 58, 34

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Program of the Sessions

The time limit for each contributed paper in the sessions is ten minutes. In the special sessions, the time limit varies from session to session and within sessions. To maintain the schedule, time limits will be strictly enforced.

Abstracts of papers presented in the sessions at this meeting will be found in the April 1990 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.

Saturday, April 7

Special Session on Classical and Quantum Groups, I

9:00 a.m.–10:50 a.m. Room 501, Keller Conference Center

- 9:00 a.m. *Sequences of divided powers in coalgebras and Hopf algebras.*
(1) **Earl J. Taft**, Rutgers University, New Brunswick (857-16-13)
- 9:30 a.m. *Quantum $GL(n)$ and q -Schur algebras.*
(2) **Richard Dipper**, University of Oklahoma (857-20-07)
- 10:00 a.m. *Integral and modular representations of q -Schur algebras.* Preliminary report.
(3) **Jie Du** and **Leonard Scott***, University of Virginia (857-20-65)
- 10:30 a.m. *Symbols and modular forms.*
(4) **Alvany Rocha*** and **Carlos J. Moreno**, Graduate School and University Center, City University of New York (857-17-53)

Special Session on Algebraic Topology, I

9:00 a.m.–10:50 a.m. Room 507, Keller Conference Center

- 9:00 a.m. *Chern character for proper Γ -manifolds.*
(5) **Hitoshi Moriyoshi**, Pennsylvania State University, University Park (857-55-55)
- 9:30 a.m. *Noncompact hyperbolic 3-orbifolds of small volume.*
(6) **Colin Adams**, Williams College (857-57-30)
- 10:00 a.m. *Geometry of the space of knots.* Preliminary report.
(7) **Jean-Luc Brylinski**, Pennsylvania State University, University Park (857-57-17)
- 10:30 a.m. *Adams operations in Hochschild and cyclic homology and applications to the topology of free loop spaces.* Preliminary report.
(8) **Dan Burghelea***, **Z. Fiedorowicz** and **W. Gajda**, Ohio State University, Columbus (857-55-71)

Special Session on Recent Progress on Einstein Manifolds and Related Topics, I

9:00 a.m.–10:50 a.m. Room 506, Keller Conference Center

- 9:00 a.m. *Compactness for families of constant mean curvature surfaces.* Preliminary report.
(9) **Rob Kusner**, University of Massachusetts, Amherst (857-53-16)
- 9:30 a.m. *Which 2-tensors can be Ricci tensors? (The rotationally symmetric case).*
(10) **Jianguo Cao**, Institute for Advanced Study (857-53-45)
- 10:00 a.m. *A construction of scalar-flat Kähler surfaces.*
(11) **Claude LeBrun**, Institute for Advanced Study and State University of New York, Stony Brook (857-53-47)
- 10:30 a.m. *The characterized standard sphere by the spectrum.*
(12) **Xingwang Xu***, University of Connecticut, Storrs, and **Paul C. Yang**, University of Southern California (857-58-46)

Special Session on Geometric Topology, I

9:30 a.m.–10:50 a.m. Room 502, Keller Conference Center

- 9:30 a.m. *An extension of simple-homotopy theory.* Preliminary report.
(13) **Steven C. Ferry**, State University of New York, Binghamton (857-55-44)
- 10:00 a.m. *Local properties of decomposition spaces.*
(14) **Steve Armentrout**, Pennsylvania State University, University Park (857-57-14)
- 10:30 a.m. *The relationship between the boundedly controlled K and Whitehead groups.*
(15) **Douglas R. Anderson**, Syracuse University (857-57-19)

Session on Convergence Problems and Differential Equations

9:35 a.m.–10:45 a.m. Room 508, Keller Conference Center

- 9:35 a.m. *Means and Taylor polynomials.*
(16) **Alan Horwitz**, Pennsylvania State University, Media (857-26-67)
- 9:50 a.m. *Comparison theorems for the ν -zeroes of Legendre functions $P_\nu^m(z_0)$ when $-1 < z_0 < 1$.*
(17) **Frank E. Baginski**, George Washington University (857-33-33)
- 10:05 a.m. *Sequences of quotients and homogeneous functions.*
(18) **Alejandro Necochea***, University of Texas, Pan American, and **Larry F. Bennett**, South Dakota State University (857-40-61)
- 10:20 a.m. *A three point connection problem for a certain third order differential equation.*
(19) **T. K. Puttaswamy**, Ball State University (857-34-70)
- 10:35 a.m. *Reflection and jump boundaries associated with the process of capital accumulation.*
(20) **Guillermo Leon Gómez Martínez**, University of Erlangen-Nürnberg, Federal Republic of Germany (857-90-01)

Invited Address

11:00 a.m.–12:00 noon Room 104, Keller Conference Center

- (21) *Rigidity for non-positively curved manifolds.*
Lowell Edwin Jones, State University of New York, Stony Brook (857-18-39)

Invited Address

1:30 p.m.–2:30 p.m. Room 104, Keller Conference Center

- (22) *Einstein metrics on algebraic manifolds.*
Gang Tian, Princeton University (857-53-31)

Special Session on Classical and Quantum Groups, II

2:45 p.m.–5:05 p.m. Room 501, Keller Conference Center

- 2:45 p.m. *Irreducible representations of quantum groups at roots of 1.*
(23) **V. G. Kac**, Massachusetts Institute of Technology (857-17-25)
- 3:15 p.m. *Twisted vertex representations of quantum affine algebras.*
(24) **Naihuan Jing**, Institute for Advanced Study (857-17-32)

- 3:45 p.m. *Tangent bundles of reductive groups. Preliminary report.*
(25) **Ivan Mirkovic**, University of Massachusetts, Amherst (857-22-43)
- 4:15 p.m. *Cyclic homology of quantum groups.*
(26) **Boris Tsygan*** and **Ping Feng**, Harvard University (857-17-69) (Sponsored by Ranee Kathryn Brylinski)
- 4:45 p.m. *Hidden quantum group symmetries and integrable perturbations of conformal field theories.*
(27) **Nikolai Reshetikhin**, Harvard University (857-17-68) (Sponsored by Ranee Kathryn Brylinski)

Special Session on Algebraic Topology, II

2:45 p.m.–5:05 p.m. Room 507, Keller Conference Center

- 2:45 p.m. *\mathcal{K} theory for bisimplicial algebras.*
(28) **Paul Baum*** and **Crichton Ogle**, Pennsylvania State University, University Park (857-55-58)
- 3:15 p.m. *A pairing theorem for group cohomology.*
(29) **Paul Baum** and **Crichton Ogle***, Pennsylvania State University, University Park (857-55-59)
- 3:45 p.m. *Cohomology of finite simple groups.*
(30) **Alejandro Adem***, Institute for Advanced Study, **John Maginnis**, University of Michigan, Ann Arbor, and **R. J. Milgram**, Stanford University (857-55-08)
- 4:15 p.m. *Rational functions and configuration spaces.*
(31) **Ralph L. Cohen**, Stanford University, and **Don H. Shimamoto***, Swarthmore College (857-55-50)
- 4:45 p.m. *Some features of the mod 2 cohomology ring of $BSpin(n)$ revealed by computer computations.*
(32) Preliminary report.
Jay A. Wood, Bowdoin College and Lehigh University (857-55-37)

Special Session on Geometric Topology, II

2:45 p.m.–4:05 p.m. Room 502, Keller Conference Center

- 2:45 p.m. *Controlled topology and algebra over non-locally compact spaces. Preliminary report.*
(33) **Christopher W. Stark**, University of Maryland, College Park and University of Florida (857-57-34)
- 3:15 p.m. *Continuous cohomology and real homotopy type II.*
(34) **Edgar H. Brown**, Brandeis University, and **Robert H. Szczarba***, Yale University (857-55-42)
- 3:45 p.m. *Finitely generated module structures on the Nil-K-theory of group rings.*
(35) **Frank Connolly*** and **Mario Da Silva**, University of Notre Dame (857-57-63)

Saturday, April 7 (cont'd)

Special Session on Recent Progress on Einstein Manifolds and Related Topics, II

2:45 p.m.-5:05 p.m. Room 506, Keller Conference Center

- 2:45 p.m. *An inequality between energy and intersection.*
(36) **C. Croke***, University of Pennsylvania, and **A. Fathi**, University of Florida (857-53-35)
- 3:15 p.m. *The Ricci flow on compact 2-orbifolds with curvature negative somewhere.*
(37) **B. Chow***, Courant Institute of Mathematical Sciences, New York University, and **N. F. Wu**, University of California at San Diego, La Jolla (857-58-40) (Sponsored by Gang Tian)
- 3:45 p.m. *Isotopy irreducible Riemannian manifolds.*
(38) **Wolfgang Ziller***, University of Pennsylvania, and **M. Wang**, McMaster University (857-53-49)
- 4:15 p.m. *Kähler-Einstein metrics of positive scalar curvature: Global algebro-geometric criteria for existence.*
(39) **Alan M. Nadel**, Massachusetts Institute of Technology (857-53-24)
- 4:45 p.m. *Applications of Einstein metrics to moduli of Calabi-Yau manifolds.*
(40) **Andrey N. Todorov**, Max-Planck-Institut für Mathematik, Bulgaria (857-53-48)

Session on Algebra, Geometry, and Homotopy

2:45 p.m.-4:10 p.m. Room 508, Keller Conference Center

- 2:45 p.m. *On characterizations of quasi-cyclic submodules.*
(41) **Johnny A. Johnson**, University of Houston, University Park, and **Monty B. Taylor***, University of Texas, Pan American (857-13-62)
- 3:00 p.m. *Paths of unimodular vectors.*
(42) **Edward K. Hinson**, University of New Hampshire (857-13-09)
- 3:15 p.m. *Coproduct decompositions of finitely generated subsemigroups of free semigroups.*
(43) **Tom Head**, State University of New York, Binghamton (857-20-15)
- 3:30 p.m. *Convexity preserving summability matrices.*
(44) **C. R. Selvaraj**, Pennsylvania State University, Sharon (857-40-22)
- 3:45 p.m. *Subvarieties of Severi varieties. Preliminary report.*
(45) **Robert Treger**, Pennsylvania State University, Delaware County Campus (857-14-23)
- 4:00 p.m. *Basic dual homotopy invariants of Riemannian foliations.*
(46) **Peter Y. Pang**, National University of Singapore, Republic of Singapore (857-57-05)

Sunday, April 8

Special Session on Classical and Quantum Groups, III

8:30 a.m.-10:50 a.m. Room 501, Keller Conference Center

- 8:30 a.m. *Compactifications of symmetric spaces and buildings associated to classical groups.*
(47) **Paul Gerardin**, Pennsylvania State University, University Park (857-22-41)
- 9:00 a.m. *Quantum deformation of flag manifolds.*
(48) **Jacob Towber**, DePaul University (857-22-56) (Sponsored by J. Marshall Ash)
- 9:30 a.m. *Sklyanin algebras.*
(49) **S. Paul Smith***, University of Washington, and **J. T. Stafford**, University of Michigan, Ann Arbor (857-16-06)
- 10:00 a.m. *Deformation methods in quantum groups.*
(50) **Murray Gerstenhaber*** and **Anthony Giaquinto**, University of Pennsylvania (857-16-60)
- 10:30 a.m. *Finite dimensional algebras and quantum groups.*
(51) Preliminary report.
Brian Parshall, University of Virginia (857-20-64)

Special Session on Algebraic Topology, III

8:30 a.m.-10:50 a.m. Room 507, Keller Conference Center

- 8:30 a.m. *$Spin^c$ cobordism determines complex K-theory.*
(52) Preliminary report.
Michael J. Hopkins, Massachusetts Institute of Technology, and **Mark Hovey***, University of New Haven (857-55-18)
- 9:00 a.m. *Splitting off H-spaces and Conner-Raymond splitting theorem.*
(53) **Giora Dula*** and **Daniel Gottlieb**, Purdue University, West Lafayette (857-55-57)
- 9:30 a.m. *Periodic families and connective cobordism via the classical Adams spectral sequence.*
(54) **Mark Mahowald**, Northwestern University, and **Paul Shick***, John Carroll University (857-55-51)
- 10:00 a.m. *Covering spaces as geometric models of cohomology operations. Preliminary report.*
(55) **Terrence P. Bisson***, Canisius College, and **André Joyal**, Université du Québec, Montréal (857-55-29)
- 10:30 a.m. *h_0 -torsion in the cohomology of subalgebras of the Steenrod algebra.*
(56) **Kenneth Monks**, Wilkes College (857-55-27)

Special Session on Geometric Topology, III

9:30 a.m.-10:50 a.m. Room 502, Keller Conference Center

- 9:30 a.m. *Closed incompressible surfaces of arbitrarily high genus in the complements of certain star knots.*
(57) **Richard F. Gustafson**, State University of New York, College at Oneonta (857-57-21)
- 10:00 a.m. *Branched covers of nonpositively curved manifolds.*
(58) **Michael Davis*** and **Ruth Charney**, Ohio State University, Columbus (857-57-10)
- 10:30 a.m. *A differential geometric characterization of symmetric spaces of higher rank.*
(59) **Patrick Eberlein***, University of North Carolina, Chapel Hill, and **Jens Heber**, Universität of Augsburg, Federal Republic of Germany (857-53-20)

Invited Address

11:00 a.m.- noon Room 104, Keller Conference Center

- (60) *On collisionless plasmas and the Vlasov-Maxwell equations.*
Robert T. Glassey, Indiana University, Bloomington (857-35-03)

Invited Address

1:30 p.m.-2:30 p.m. Room 104, Keller Conference Center

- (61) *Geometry and topology of manifolds curved from below.*
Karsten Grove, University of Maryland, College Park (857-53-38)

Special Session on Classical and Quantum Groups, IV

2:45 p.m.-4:35 p.m. Room 501, Keller Conference Center

- 2:45 p.m. *Decompositions of some S_n -modules arising in the free Lie algebra.*
(62) **Sheila Sundaram**, Université du Québec, Montréal (857-22-36)
- 3:15 p.m. *A Bernstein-Beilinson theorem for $U_q(\mathfrak{sl}(2))$. Preliminary report.*
(63) **T. J. Hodges**, University of Cincinnati (857-16-02)
- 3:45 p.m. *Schubert calculus for generalized cohomology.*
(64) **Paul Bressler**, Purdue University, West Lafayette, and **Sam Evens***, Rutgers University, New Brunswick (857-57-52)

- 4:15 p.m. *Good bases for G -modules.*
(65) **Olivier Mathieu**, Institute for Advanced Study (857-22-72)

Special Session on Algebraic Topology, IV

2:45 p.m.-4:35 p.m. Room 507, Keller Conference Center

- 2:45 p.m. *On the self-homotopy equivalences of an infinite cell complex.*
(66) **Joseph Roitberg**, Hunter College, City University of New York (857-55-28)
- 3:15 p.m. *Rational homotopy types with cohomology of stunted complex projective space.*
(67) **Gregory M. Lupton**, Dartmouth College, and **Ronald N. Umble***, Millersville University of Pennsylvania (857-55-26)
- 3:45 p.m. *2-Primary, v_1 -periodic homotopy of $SU(n)$.*
(68) **Martin Bendersky**, Hunter College, City University of New York (857-55-12) (Sponsored by Donald M. Davis)
- 4:15 p.m. *On splittings of the tangent bundles of 4-manifolds.*
(69) **Duane Randall**, Loyola University (857-55-11)

Special Session on Geometric Topology, IV

2:45 p.m.-4:05 p.m. Room 502, Keller Conference Center

- 2:45 p.m. *Group actions and cohomology of discrete groups.*
(70) **Alejandro Adem**, Institute for Advanced Study (857-57-04)
- 3:15 p.m. *Examples of lack of rigidity in crystallographic groups.*
(71) **Frank Connolly** and **Tadeusz Koźniewski***, University of Notre Dame (857-57-66)
- 3:45 p.m. *Topological realization of the Dennis trace.*
(72) **Ross Geoghegan**, State University of New York, Binghamton (857-57-54)

W. Wistar Comfort
Associate Secretary
Middletown, Connecticut

Presenters of Papers

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ACCESSIBLE CATEGORIES: THE FOUNDATIONS OF CATEGORICAL MODEL THEORY

Michael Makkai and Robert Paré

(Contemporary Mathematics, Volume 104)

Intended for category theorists and logicians familiar with basic category theory, this book focuses on categorical model theory, which is concerned with the categories of models of infinitary first order theories, called accessible categories. The starting point is a characterization of accessible categories in terms of concepts familiar from Gabriel-Ulmer's theory of locally presentable categories. Most of the work centers on various constructions (such as weighted bilimits and lax colimits), which, when performed on accessible categories, yield new accessible categories. These constructions are necessarily 2-categorical in nature; the authors cover some aspects of 2-category theory, in addition to some basic model theory, and some set theory. One of the main tools used in this study is the theory of mixed sketches in which the authors specialize to give concrete results about model theory. Many examples illustrate the extent of applicability of these concepts. In particular, some applications to topos theory are given.

Perhaps this book's most significant contribution is the way it sets model theory in categorical terms, opening the door for further work along these lines. Requiring a basic background in category theory, this book will provide readers with an understanding of model theory in categorical terms, familiarity with 2-categorical methods, and a useful tool for studying toposes and other categories.

1980 *Mathematics Subject Classifications*: 18C10, 03G30, 03C95, 18D05; 18B25, 03E55, 03C75
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Albuquerque, New Mexico

University of New Mexico

April 19 - 21

Program

The eight-hundred-and-fifty-eighth meeting of the American Mathematical Society will be held at the Sheraton Old Town Hotel in Albuquerque, New Mexico, on Thursday, April 19, Friday, April 20, and Saturday, April 21, 1990. This meeting is being held in cooperation with the Society for Industrial and Applied Mathematics (SIAM) and being hosted by the University of New Mexico.

Invited Addresses

By invitation of the Far Western Section Program Committee, and in cooperation with SIAM, there will be six invited addresses. The speakers, their affiliations, and the titles of their talks are:

DAVID CAMPBELL, Los Alamos National Laboratory, *Solitary waves and their interactions in non-integrable nonlinear partial differential equations*, 11:00 a.m. Saturday.

PETER B. GILKEY, University of Oregon, *Can one hear the shape of a drum?*, 11:30 a.m. Thursday

GERHARD KRISTENSSON, Lund University, *Recent development in time domain inverse scattering theory using invariant imbedding techniques*, 11:30 a.m. Friday.

ROBERT M. MAY, Oxford University, *Transmission dynamics of HIV/AIDS*, 1:30 p.m. Saturday.

ALAN C. NEWELL, University of Arizona, *Convection patterns in large containers*, 5:00 p.m. Thursday.

MARC A. RIEFFEL, University of California, Berkeley, *Quantum groups and operator algebras*, 5:00 p.m. Friday.

Special Sessions

By invitation of the same committee, and in cooperation with SIAM, there will be seven special sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Numerical solution of partial differential equations, RICHARD C. ALLEN, Sandia National Laboratory, JOSÉ CASTILLO, San Diego State University, and STANLEY STEINBERG, University of New Mexico.

Geometry and topology of moduli spaces, CHARLES P. BOYER, and BENJAMIN M. MANN, University of New Mexico.

Real algebraic geometry, MICHAEL A. BUCHNER, University of New Mexico, and WOJCIECH KUCHARZ, University of Hawaii and University of New Mexico.

Dynamical systems: low dimensional behavior in partial differential equations, DAVID CAMPBELL, and JAMES M. HYMAN, Los Alamos National Laboratory.

Invariant imbedding and inverse problems, JAMES CORONES, Ames Laboratory, PAUL NELSON, Texas A&M, and DANIEL SETH, Ames Laboratory.

Differential geometry, HOWARD FEGAN and ALEXANDER P. STONE, University of New Mexico.

Mathematical biology, JAMES M. HYMAN, W. T. KYNER, University of New Mexico, ANN STANLEY, Los Alamos National Laboratory, DEBORAH SULSKY, University of New Mexico, and CARLA WOFSY, University of New Mexico.

Contributed Papers

There will also be a session for contributed ten-minute papers. Late papers will not be accommodated.

Council

The Council of the AMS will meet at 7:00 p.m. on Thursday, April 19, 1990, in the Fireplace Room at the Sheraton Old Town Hotel.

Activities of Other Organizations

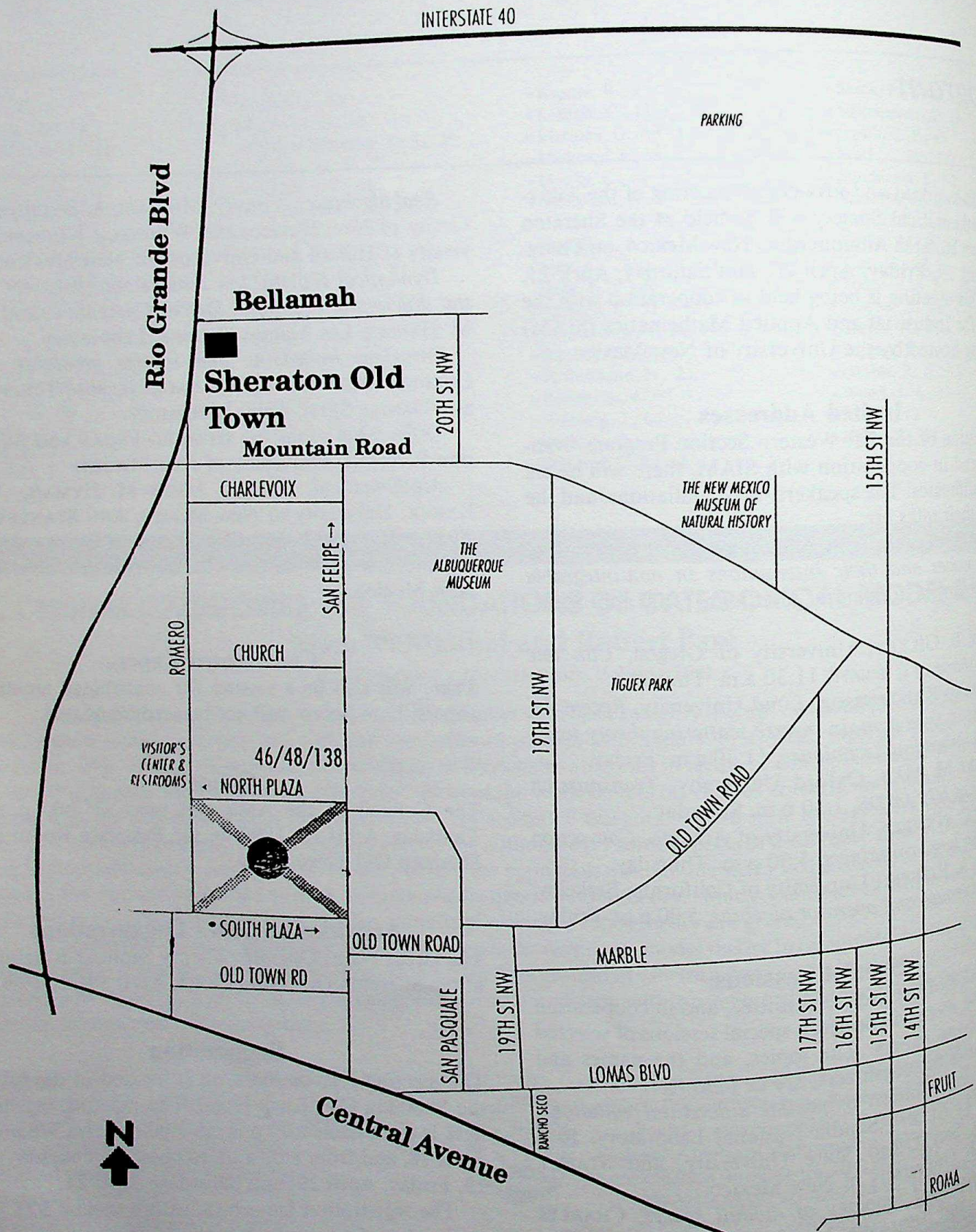
The Great Plains Operator Theory Seminar is being held at the Sheraton Old Town Hotel, April 19-21, 1990.

Registration

The meeting registration desk is located in the lobby of the Sheraton Old Town Hotel. The meeting registration desk is open from 6:00 p.m. to 9:00 p.m. on Wednesday, April 18, and from 8:00 a.m. to noon on Thursday, April 19, Friday, April 20, and Saturday, April 21.

The registration fee is \$45, with a special \$25 fee for graduate students and unemployed mathematicians, and a one-day fee of \$25.

Albuquerque, New Mexico



Social Event

On Friday evening, April 20, there will be a reception and a no-host bar at the New Mexico Museum of Natural History. During the evening participants will have exclusive access to most of the exhibits at this outstanding museum.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Louisville meeting announcement in the October 1989 issue of *Notices*.

David II Report

The special presentation and discussion scheduled at the reception Friday evening concerning the upcoming National Research Council David II Report has been cancelled.

Accommodations

A block of rooms is being held at the Sheraton Old Town Hotel and at the Rio Grande Inn, which is within walking distance. Participants should make their own reservations directly with the hotels listed below and identify themselves as participants of the AMS and SIAM meeting in order to obtain the rates listed. Participants must make reservations 45 days in advance of the meeting to be assured of the quoted rates. The American Mathematical Society is not responsible for rate changes or accommodations offered by hotels/motels in the following list.

Sheraton Old Town Hotel

800 Rio Grande Boulevard NW
Albuquerque, NM 87104

Telephone: 505-843-6300 or 800-237-2133

Single or Double \$53

Rio Grande Inn

1015 Rio Grande Boulevard NW
Albuquerque, NM 87104

Telephone: 505-843-9500

Single \$29

Double \$32

Food Service

There are a number of restaurants on the square and in the downtown area. Complete listings are available at the meeting registration desk.

Travel

The Albuquerque Airport is served by most airlines. Both the Sheraton Old Town Hotel and the Rio Grande Inn provide free airport shuttle service. The Albuquerque City Bus (Sun-Tran) runs from the airport through the downtown area at seven minutes after the hour, and at thirty-seven minutes after the hour. The Sun-Tran Bus number is #50. Participants may board the bus on the west side of the airport on the lower level and the fare is sixty cents one-way. Cab service is also available for approximately \$7 one-way.

Weather and Local Attractions

April temperatures in Albuquerque are mild, although participants are advised to bring a sweater or light jacket. Nearby ski areas may still be open at the time of the meeting. Old Town, in Albuquerque, has a historic plaza, Museum of Art, Museum of Natural History, and many restaurants, shops, and galleries. Albuquerque is also home to the world's longest tramway, the Sandia Peak Tramway.

Program of the Sessions

The time limit for each contributed paper in the sessions is ten minutes. In the special sessions, the time limit varies from session to session and within sessions. To maintain the schedule, time limits will be strictly enforced.

Abstracts of papers presented in the sessions at this meeting will be found in the April 1990 issue of *Abstracts of papers presented to the American Mathematical Society*, ordered according to the numbers in parentheses following the listings below.

For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting.

Thursday, April 19

AMS Special Session on Real Algebraic Geometry, I

8:30 a.m.-10:50 a.m. Potters Room, Sheraton Old
Town Hotel

- 8:30 a.m. *Elliptic curves and real algebraic morphisms into*
(1) *2-spheres.*
Wojciech Kucharz, University of Hawaii, Honolulu
(858-14-91)
- 9:00 a.m. *Some new results on the topology of nonsingular real*
(2) *algebraic sets.*
Selman Akbulut*, Michigan State University, and
Henry King, University of Maryland, College Park
(858-57-65)
- 9:30 a.m. *Relative real holomorphy rings.*
(3) **M. Buchner***, University of New Mexico, and **W.**
Kucharz, University of Hawaii, Honolulu (858-14-48)
- 10:00 a.m. *Real algebraic transformation groups.*
(4) **Karl Heinz Dovermann**, University of Hawaii,
Honolulu (858-57-49)
- 10:30 a.m. Discussion

AMS Special Session on Invariant Embedding and Inverse Problems, I

8:30 a.m.-10:50 a.m. Weaver Room, Sheraton
Old Town Hotel

- 8:30 a.m. *An electromagnetic inverse problem in medical*
(5) *science.*
Richard A. Albanese* and **John W. Penn**, Radiation
Sciences Division, Brooks AFB, Texas (858-35-10)
- 9:00 a.m. *The inverse scattering problem for hyperbolic systems*
(6) *in semi-infinite media.*
Isam S. Ayoubi, King Fahd University of Petroleum
and Minerals, Saudi Arabia (858-35-20) (Sponsored
by Faruk F. Abi-Khuzam)

- 9:30 a.m. *Invariant imbedding, layer-stripping, and impedance*
(7) *imaging.* Preliminary report.
Margaret Cheney* and **David Isaacson**, Rensselaer
Polytechnic Institute (858-35-13)

- 10:00 a.m. *Exact and approximate solutions of the (Helmholtz)*
(8) *Weyl composition equation in direct and inverse*
scattering.

Louis Fishman, Colorado School of Mines
(858-35-06)

- 10:30 a.m. *Inverse problems in underwater acoustics.*
(9) **Robert P. Gilbert*** and **Y. Xu**, University of Delaware
(858-35-22)

AMS Invited Address

11:30 a.m.-12:20 p.m. Rio Grande Ballroom,
Sheraton Old Town Hotel

- (10) *Can one hear the shape of a drum?*
Peter B. Gilkey, University of Oregon (858-58-11)

AMS Special Session on Geometry and Topology of Moduli Spaces, I

2:00 p.m.-5:00 p.m. Isleta Room, Sheraton Old
Town Hotel

- 2:00 p.m. *The topology of certain holomorphic mapping spaces*
(11) **Benjamin M. Mann***, University of New Mexico, and
R. James Milgram, Stanford University (858-58-44)

- 2:30 p.m. *On the structure of certain spaces of polynomials.*
(12) Preliminary report.
Martin Guest, University of Rochester (858-55-35)

- 3:00 p.m. *On some spaces of real algebraic cycles.* Preliminary
(13) report.
T. K. Lam, State University of New York, Stony Brook
(858-55-36)

- 3:30 p.m. *Rational functions, Cayley-Dickson algebras, and the*
(14) *Whitehead product.* Preliminary report.
Fred Cohen, University of Rochester (858-55-66)

4:00 p.m. Discussion

AMS Special Session on Differential Geometry, I

2:00 p.m.-5:00 p.m.

Potters Room, Sheraton Old Town Hotel

- 2:00 p.m. *Finiteness of diffeomorphism types of isospectral manifolds.*
(15) **Robert Brooks***, University of California, Los Angeles, **Peter Perry**, University of Kentucky, and **Peter Petersen, V.**, University of California, Los Angeles (858-58-18)
- 2:30 p.m. *Vibrating fractal drums, the Weyl-Berry problem for the eigenvalues of the Laplacian, and spectral zeta-functions.* Preliminary report.
(16) **Michel L. Lapidus**, University of Georgia (858-58-33)
- 3:00 p.m. *The spectrum of a surface of revolution.* Preliminary report.
(17) **Martin Engman**, University of New Mexico (858-53-89)
- 3:30 p.m. *The functional determinant and eta invariant in 3 and 4 dimensions.*
(18) **Thomas P. Branson**, University of Iowa (858-53-77)
- 4:00 p.m. *The isospectral problem on manifolds with boundary.*
(19) **Matthew J. Gursky**, California Institute of Technology (858-58-63)
- 4:30 p.m. Discussion

AMS Special Session on Numerical Solution of Partial Differential Equations, I

2:00 p.m.-5:00 p.m.

Jemes Room, Sheraton Old Town Hotel

- 2:00 p.m. *Symmetric differencing of symmetric operators.*
(20) **Stanly Steinberg***, University of New Mexico, and **Patrick J. Roache**, Ecodynamics Research Associates Inc., Albuquerque, New Mexico (858-39-54)
- 2:30 p.m. *High order finite volume approximations of differential operators on nonuniform grids.*
(21) **James M. Hyman*** and **Robert J. Knapp**, Los Alamos National Laboratory (858-65-71)
- 3:00 p.m. *On discretization errors in the numerical solution of PDE's on generalized coordinate meshes.*
(22) **Richard G. Hindman**, Iowa State University (858-35-83) (Sponsored by Stanly L. Steinberg)
- 3:30 p.m. *Multipoint constraints through projection operators with applications to the finite element method.*
(23) **Howard L. Schreyer**, University of New Mexico (858-65-84) (Sponsored by Stanly L. Steinberg)
- 4:00 p.m. *Conservative, staggered grid discretization for general curvilinear coordinates.*
(24) **Marcel Vinokur**, Sterling Software, Palo Alto, California (858-39-92) (Sponsored by Stanly L. Steinberg)

- 4:30 p.m. *Supraconvergent difference schemes for high performance computational problems.*
(25) **Andrew B. White, Jr.**, Los Alamos National Laboratory (858-35-98) (Sponsored by Stanly L. Steinberg)

AMS Invited Address

5:00 p.m.-5:50 p.m.

Rio Grande Ballroom, Sheraton Old Town Hotel

- (26) *Convection patterns in large containers.*
Alan C. Newell, University of Arizona (858-99-95)

AMS Council

7:00 p.m.-

Fireplace Room, Sheraton Old Town Hotel

Friday, April 20

AMS Special Session on Geometry and Topology of Moduli Spaces, II

8:30 a.m.-10:50 a.m.

Isleta Room, Sheraton Old Town Hotel

- 8:30 a.m. *Morse theory and the hyperkähler geometry of $k = 2$ instantons on S^4 .*
(27) **Charles P. Boyer*** and **Benjamin M. Mann**, University of New Mexico (858-58-45)
- 9:00 a.m. *Monopoles, braid groups and the Dirac operator.*
(28) **Ralph L. Cohen***, Stanford University, and **John Jones**, Mathematical Sciences Research Institute, Berkeley (858-55-56)
- 9:30 a.m. *Metric properties of monopole moduli spaces.*
(29) Preliminary report.
Jacques Hurtubise, McGill University (858-53-67)
- 10:00 a.m. *The moduli space of instantons.*
(30) **Ralph L. Cohen**, Stanford University, and **John Jones***, Mathematical Sciences Research Institute, Berkeley (858-55-57)
- 10:30 a.m. Discussion

AMS Special Session on Real Algebraic Geometry, II

8:30 a.m.-10:50 a.m.

Potters Room, Sheraton Old Town Hotel

- 8:30 a.m. *Convex sets and metrics over non-archimedean ordered fields.*
(31) **Robert O. Robson**, Oregon State University (858-46-81)

Friday, April 20 (cont'd)

- 9:00 a.m. *Noncommutative real algebraic geometry*. Preliminary report.
(32) **Victoria Powers**, Emory University (858-14-74)
- 9:30 a.m. *Separating ideals*. Preliminary report.
(33) **James Madden**, Indiana University, South Bend (858-14-69)
- 10:00 a.m. *Suprema of infima of rational functions*. Preliminary report.
(34) **Charles N. Delzell**, Louisiana State University, Baton Rouge (858-14-80)
- 10:30 a.m. Discussion

AMS Special Session on Dynamical Systems: Low Dimensional Behavior in Partial Differential Equations, I

8:30 a.m.–10:50 a.m. James Room, Sheraton Old Town Hotel

- 8:30 a.m. *Calculating stable and unstable manifolds*.
(35) **Eric J. Kostelich***, Arizona State University, **James A. Yorke** and **Zhiping You**, University of Maryland, College Park (858-34-40)
- 9:00 a.m. *Homoclinic chaos and vorticity explosions in Navier-Stokes flows*.
(36) **Basil Nicolaenko**, Arizona State University (858-76-39)
- 9:30 a.m. Discussion

AMS Special Session on Mathematical Biology, I

8:30 a.m.–10:50 a.m. Sandia Room, Sheraton Old Town Hotel

- 8:30 a.m. *Numerical methods for structured population models*.
(37) **Deborah Sulsky**, University of New Mexico (858-92-94)
- 9:00 a.m. Discussion and Open Problems

AMS Special Session on Invariant Embedding and Inverse Problems, II

8:30 a.m.–10:50 a.m. Weaver Room, Sheraton Old Town Hotel

- 8:30 a.m. *Tomography with diffusion*.
(38) **F. Alberto Grunbaum**, University of California, Berkeley (858-60-29) (Sponsored by Paul Nelson)
- 9:00 a.m. *Wave propagation in gyrotropic media*.
(39) **Anders Karlsson***, **Henrik Otterheim**, Stockholm, Sweden, and **Gerhard Kristensson**, Lund University, Sweden (858-35-30) (Sponsored by Paul Nelson)

- 9:30 a.m. *A wave splitting approach to transient electromagnetic scattering for the dispersive sphere*. Preliminary report.
(40) **Kevin Kreider**, University of Akron (858-78-15) (Sponsored by Subramaniya I. Hariharan)
- 10:00 a.m. *An optimization problem in electromagnetic wave propagation*.
(41) **Robert Ochs***, University of Toledo, and **Curtis Vogel**, Montana State University (858-78-16)
- 10:30 a.m. *Inverse scattering for electromagnetically dispersive media*. Preliminary report.
(42) **Thomas M. Roberts*** and **Mike Hobart**, Ames Laboratory, Ames, Iowa (858-78-31) (Sponsored by Paul Nelson)

AMS-SIAM Invited Address

11:30 a.m.–12:20 p.m. Rio Grande Ballroom, Sheraton Old Town Hotel

- (43) *Recent development in time domain inverse scattering theory using invariant imbedding techniques*.
Gerhard Kristensson, Lund University, Sweden (858-78-61) (Sponsored by Paul Nelson)

AMS Special Session on Geometry and Topology of Moduli Spaces, III

2:00 p.m.–4:50 p.m. Isleta Room, Sheraton Old Town Hotel

- 2:00 p.m. *Vortices and stable bundles*.
(44) **Steve Bradlow**, University of California at San Diego, La Jolla (858-58-37)
- 2:30 p.m. *Real analytic structures on the moduli space of curves*.
(45) **Michael Wolf**, Rice University (858-58-46)
- 3:00 p.m. *Vortices on asymptotically Euclidean Riemann surfaces*.
(46) **Yisong Yang**, University of New Mexico (858-58-47)
- 3:30 p.m. *The geometry of complex superspaces*. Preliminary report.
(47) **D. Sundararaman**, University of California at San Diego, La Jolla (858-58-90)
- 4:00 p.m. *Closed string field theory: Topology and convolution algebra*. Preliminary report.
(48) **Jim Stasheff**, University of North Carolina, Chapel Hill (858-55-58)
- 4:30 p.m. Discussion

AMS Special Session on Differential Geometry, II

2:00 p.m.-5:00 p.m.

Potters Room, Sheraton Old
Town Hotel

- 2:00 p.m. *Spectral invariants for the conformal Laplacian.*
(49) Preliminary report.
Paul Yang, University of Southern California
(858-53-82)
- 2:30 p.m. *Hamilton-Jacobi distributions and the Lorentz force*
(50) *law.*
Geoffrey Martin, University of Toledo (858-53-09)
- 3:00 p.m. *An algorithm for exact linearization.* Preliminary report.
(51) **Robert B. Gardner***, University of North Carolina,
Chapel Hill, and **William F. Shadwick**, University of
Waterloo (858-93-21)
- 3:30 p.m. *Local existence of multivalued solutions to simplectic*
(52) *Monge Ampere equations.*
Marek Kossowski, University of South Carolina,
Columbia (858-35-96) (Sponsored by Robert B.
Gardner)
- 4:00 p.m. *Absolute equivalence of differential systems and*
(53) *dynamic feedback linearization.* Preliminary report.
William F. Shadwick, University of Waterloo
(858-34-12)
- 4:30 p.m. Discussion

AMS Special Session on Mathematical Biology, II

2:00 p.m.-5:00 p.m.

Sandia Room, Sheraton Old
Town Hotel

- 2:00 p.m. *Stochastic and deterministic models of HIV*
(54) *transmission in IVDU populations.*
Michael Altmann*, **Keith Willard**, **Denton Peterson**
and **Laël Gatewood**, University of Minnesota,
Minneapolis (858-92-73)
- 2:30 p.m. *Modeling early stages of HIV infection.*
(55) **Stephen J. Merrill**, Marquette University (858-92-60)
(Sponsored by Walter T. Kyner)
- 3:00 p.m. *Modeling the effects of HIV on the human immune*
(56) *system.*
Alan S. Perelson, Los Alamos National Laboratory
(858-92-72) (Sponsored by James M. Hyman)
- 3:30 p.m. *Functional differential equations in age-structured*
(57) *AIDS epidemic models.*
Jia Li*, Los Alamos National Laboratory, and **Hisashi**
Inaba, University of Leiden, The Netherlands
(858-92-42)
- 4:00 p.m. Discussion

AMS Special Session on Numerical Solution of Partial Differential Equations, II

2:00 p.m.-5:00 p.m.

Jemes Room, Sheraton Old
Town Hotel

- 2:00 p.m. *Multilevel adaptive methods for partial differential*
(58) *equations.*
Steve McCormick, University of Colorado, Denver
(858-65-85) (Sponsored by David E. Womble)
- 2:30 p.m. *A parallel time stepping algorithm for nonlinear*
(59) *equations.*
David E. Womble* and **Lorraine S. Baca**, Sandia
National Laboratories, Albuquerque, New Mexico
(858-65-87)
- 3:00 p.m. *Lattice gas methods for hydrodynamics.*
(60) **Gary Doolen**, Los Alamos National Laboratory
(858-65-88) (Sponsored by David E. Womble)
- 3:30 p.m. *Solution of PDEs on a hypercube: Algorithms and*
(61) *applications.*
Robert E. Benner, Sandia National Laboratories,
Albuquerque, New Mexico (858-65-86) (Sponsored
by David E. Womble)
- 4:00 p.m. Discussion

AMS Invited Address

5:00 p.m.-5:50 p.m.

Rio Grande Ballroom, Sheraton
Old Town Hotel

- (62) *Quantum groups and operator algebras.*
Marc A. Rieffel, University of California, Berkeley
(858-46-28)

Saturday, April 21

AMS Special Session on Dynamical Systems: Low Dimensional Behavior in Partial Differential Equations, II

8:30 a.m.-10:50 a.m.

Isleta Room, Sheraton Old
Town Hotel

- 8:30 a.m. *Low dimensional dynamical approximations.*
(63) **Lawrence Sirovich**, Brown University (858-76-38)
- 9:00 a.m. *Dynamics of the nonlinear Schrodinger equation.*
(64) Preliminary report.
Stephen Wiggins*, California Institute of Technology
and Los Alamos National Laboratory, and **David**
McLaughlin, Princeton University (858-35-75)
(Sponsored by Heinz-Otto Kreiss)
- 9:30 a.m. Discussion

Saturday, April 21 (cont'd)

AMS Special Session on Differential Geometry, III

8:30 a.m.-10:50 a.m. Potters Room, Sheraton Old
Town Hotel

- 8:30 a.m. *Non-existence of 4-dimensional almost Kaehler
(65) manifolds of constant curvature.*
David E. Blair, Michigan State University (858-53-01)
- 9:00 a.m. *Actions of loop groups on harmonic maps.
(66)* **Maarten Bergvelt**, University of Georgia, and **Martin
Guest***, University of Rochester (858-53-34)
- 9:30 a.m. *Volumes of foliations on spheres. Preliminary report.
(67)* **David L. Johnson*** and **Penny Smith**, Lehigh
University (858-53-03)
- 10:00 a.m. *On the number of minimal two-spheres of small area in
(68) manifolds with curvature bounded above. Preliminary
report.*
John Douglas Moore, University of California, Santa
Barbara (858-53-08)
- 10:30 a.m. *Morse theory on the spinor groups. Preliminary report.
(69)* **Jay A. Wood**, Bowdoin College and Lehigh University
(858-57-79)

AMS Special Session on Mathematical Biology, III

8:30 a.m.-10:50 a.m. Sandia Room, Sheraton Old
Town Hotel

- 8:30 a.m. *Population dynamics in a time-varying environment.
(70)* **Richard R. Vance**, University of California, Los
Angeles (858-92-76) (Sponsored by Deborah L.
Sulsky)
- 9:00 a.m. *Dynamics of competing or cooperating species.
(71)* **Morris W. Hirsch**, University of California, Berkeley
(858-99-100)
- 9:30 a.m. *Microbial competition in the gradostat.
(72)* **Hal L. Smith**, Arizona State University (858-99-99)
- 10:00 a.m. Discussion

AMS Special Session on Invariant Embedding and Inverse Problems, III

8:30 a.m.-10:50 a.m. Weaver Room, Sheraton
Old Town Hotel

- 8:30 a.m. *Undetermined coefficient problems for quasilinear
(73) parabolic equations.*
Michael Pilant and **William Rundell***, Texas A & M
University, College Station (858-30-02)

- 9:00 a.m. *Wave splitting for some nonhyperbolic time-dependent
(74) PDE's. Preliminary report.*
Curtis R. Vogel, Montana State University
(858-35-05)

- 9:30 a.m. *Fast numerical solution of non-linear functional
(75) differential equations pertaining to time domain inverse
scattering for a dissipative wave equation.*
David J.N. Wall, University of Canterbury, New
Zealand (858-65-14) (Sponsored by Kevin C.
O'Meara)

10:00 a.m. Discussion

AMS Special Session on Numerical Solution of Partial Differential Equations, III

8:30 a.m.-10:50 a.m. Jemes Room, Sheraton Old
Town Hotel

- 8:30 a.m. *Discrete variational grid generation.
(76)* **José E. Castillo**, San Diego State University
(858-65-52)
- 9:00 a.m. *Parameter estimation for discrete variational grid
(77) generation.*
Daria F. Buonassisi* and **José E. Castillo**, San Diego
State University (858-65-50) (Sponsored by Stanley L.
Steinberg)
- 9:30 a.m. *Robust grid generation on surfaces of large curvature.
(78)* **Patrick M. Knupp**, Ecodynamics Research
Associates, Inc., Albuquerque, New Mexico
(858-76-17)
- 10:00 a.m. *Existence and uniqueness of a class of elliptic
(79) differential equations.*
Gordon Liao, University of Texas, Arlington
(858-53-62)
- 10:30 a.m. *Mathematical theory of harmonic grid generation.
(80)* **S. S. Sritharan**, University of Southern California
(858-35-53)

AMS-SIAM Invited Address

11:00 a.m.-11:50 a.m.

Rio Grande Ballroom,
Sheraton Old Town Hotel

- (81) *Solitary waves and their interactions in non-integrable
nonlinear partial differential equations.*
David Campbell, Los Alamos National Laboratory
(858-99-97)

AMS-SIAM Invited Address

1:30 p.m.-2:20 p.m.

Rio Grande Ballroom, Sheraton
Old Town Hotel

- (82) *Transmission dynamics of HIV/AIDS.*
Robert M. May, University of Oxford, England
(858-92-32)

AMS Special Session on Mathematical Biology, IV

2:00 p.m. - 5:00 p.m.

Sandia Room, Sheraton Old
Town Hotel

- 2:00 p.m. *Latin hypercubes, partial rank correlation coefficients and HIV epidemiology in intravenous drug-using communities.*
(83) **Sally Blower***, Imperial College, England, **Hadi Dowlatbadi**, Rockefeller Foundation, **Robert M. May**, Oxford University, England, and **Roy Anderson**, Imperial College, England (858-92-43) (Sponsored by Walter T. Kyner)
- 2:30 p.m. *Modeling HIV transmission and AIDS in the major risk groups.* Preliminary report.
(84) **Herbert W. Hethcote**, University of Iowa (858-92-41)
- 3:00 p.m. *Some worst case results for mixing models of AIDS.*
(85) **Edward H. Kaplan**, Yale University (858-92-64) (Sponsored by Stanly L. Steinberg)
- 3:30 p.m. *Modeling the spread of HIV in Africa.*
(86) **E. Ann Stanley**, Los Alamos National Laboratory (858-92-70) (Sponsored by Walter T. Kyner)
- 4:00 p.m. *Liapunov functions for the stability of equilibria in a model of HIV spread.* Preliminary report.
(87) **John Jacquez** and **Carl P. Simon***, University of Michigan, Ann Arbor (858-99-101)
- 4:30 p.m. Discussion

AMS Special Session on Invariant Embedding and Inverse Problems, IV

2:00 p.m. - 3:20 p.m.

Weaver Room, Sheraton Old
Town Hotel

- 2:00 p.m. *Invariant imbedding and inverse problem of reflection.*
(88) **Alan P. Wang**, Arizona State University (858-99-04) (Sponsored by Cecilia Y. Wang)
- 2:30 p.m. *Wave splitting for a class of hyperbolic equations.*
(89) **Vaughan H. Weston**, Purdue University, West Lafayette (858-35-07)
- 3:00 p.m. *Inverse problems and the optimization of kernels.*
(90) **John D. Zahrt**, Los Alamos National Laboratory (858-45-19) (Sponsored by William A. Beyer)

AMS Special Session on Numerical Solution of Partial Differential Equations, IV

2:30 p.m. - 5:30 p.m.

Jemes Room, Sheraton Old
Town Hotel

- 2:30 p.m. *Discrete variational grids and solution of elliptic partial differential equations.*
(91) **José E. Castillo** and **Lynne A. Tablewski***, San Diego State University (858-65-51) (Sponsored by Stanly L. Steinberg)

- 3:00 p.m. *Surface grid generation and differential geometry.*
(92) **Z. U. A. Warsi**, Mississippi State University (858-65-78) (Sponsored by Stanly L. Steinberg)

- 3:30 p.m. *The mixed finite element method.*
(93) **Thomas H. Robey**, University of New Mexico (858-35-55)

- 4:00 p.m. *Computation of invariant manifolds on multicomputers.*
(94) **Jens Lorenz***, University of New Mexico, and **Eric Van de Velde**, California Institute of Technology (858-65-68)

- 4:30 p.m. *Adaptive grid generation from harmonic maps.*
(95) **Arkady S. Dvinsky**, Creare Inc., Hanover, New Hampshire (858-65-93) (Sponsored by Stanly L. Steinberg)

- 5:00 p.m. Discussion

AMS General Session

2:30 p.m. - 4:20 p.m.

Isleta Room, Sheraton Old
Town Hotel

- 2:30 p.m. *Condition P for real analytic singular differential forms in the plane.*
(96) **Abdelhamed Meziani**, Florida International University (858-35-23)
- 2:50 p.m. *Multipliers of Besov spaces on certain groups.*
(97) **Hitoshi Ombe**, University of Puerto Rico, Rio Piedras (858-43-24)
- 3:10 p.m. *Completion of a quasi local ring.* Preliminary report.
(98) **J. H. Kim**, East Carolina University (858-13-25)
- 3:30 p.m. *Differentiation formulas for generalized Wiener functionals with multiparameter time.* Preliminary report.
(99) **Mylan Redfern*** and **David E. Betounes**, University of Southern Mississippi (858-60-26)
- 3:50 p.m. *Two magnetic monopole Julia sets.* Preliminary report.
(100) **M. Temple-Raston**, University of Arizona (858-70-27)
- 4:10 p.m. *An optimal control problem in exterior hydrodynamics.*
(101) **S. S. Sritharan**, University of Southern California (858-35-59)

Lance W. Small
AMS Associate Secretary
La Jolla, California

Presenters of Papers

Numbers following the names indicate the speakers' positions on the program.

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- AMS-SIAM Invited Lecturer

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ALGEBRAIC TOPOLOGY

Mark Mahowald and Stewart Priddy
(Contemporary Mathematics, Volume 96)

This book will provide readers with an overview of some of the major developments in current research in algebraic topology. Representing some of the leading researchers in the field, the book contains the proceedings of the International Conference on Algebraic Topology, held at Northwestern University in March, 1988. Several of the lectures at the conference were expository and will therefore appeal to topologists in a broad range of areas.

The primary emphasis of the book is on homotopy theory and its applications. The topics covered include elliptic cohomology, stable and unstable homotopy theory, classifying spaces, and equivariant homotopy and cohomology. Geometric topics—such as knot theory, divisors and configurations on surfaces, foliations, and Siegel spaces—are also discussed. Researchers wishing to follow current trends in algebraic topology will find this book a valuable resource.

1980 *Mathematics Subject Classifications*: 55-06; 55P42, 55P45, 55R45, 55T15, 18F25
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Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

Columbus, OH, August 1990

Joseph G. Conlon	John Morgan
Michael G. Crandall	(Progress in
(Progress in	Mathematics Lecture)
Mathematics Lecture)	Michael E. Taylor
Saunders Mac Lane (AMS-MAA)	

Denton, TX, November 1990

Avner D. Ash	John Leucke
Peter S. Constantin	Clarence W. Wilkerson

Invited addresses at Sectional Meetings are selected by the Section Program Committee, usually twelve to eighteen months in advance of a meeting. Members wishing to nominate candidates for invited addresses should send the relevant information to the Associate Secretary for the Section who will forward it to the Section Program Committee.

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

August 1990 Meeting in Columbus, Ohio

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: April 27, 1990

Eiichi Bannai, Thomas A. Dowling, Dijen Ray-Chaudhuri and Neil Robertson, *Combinatorics*

Susan Jane Colley and Gary Kennedy, *Algebraic geometry*
Zita M. Divis and David Terman, *Dynamics of biological systems*

Richard K. Guy and Richard J. Nowakowski, *Combinatorial games*

S. K. Jain and S. Tariq Rizvi, *Ring theory*

Surinder K. Sehgal and Ronald Solomon, *Group theory*

October 1990 Meeting in Amherst, Massachusetts Eastern Section

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: July 16, 1990

Colin C. Adams, *Hyperbolic manifolds*

Melvyn S. Berger, *Non-linear dynamics in mathematics and science*

Haskell Cohen, *Semigroups*

James E. Humphreys and Ivan Mirković, *Lie groups and algebraic groups*

Chjan C. Lim, *Algebraic graph theory*

V. S. Prasad, *Ergodic theory*

November 1990 Meeting in Denton, Texas Central Section

Associate Secretary: Andy Roy Magid

Deadline for organizers: Expired

Deadline for consideration: July 16, 1990

Avner D. Ash and Mark S. Reeder, *Arithmetic groups*

Elizabeth M. Bator, Russell G. Bilyeu and Paul W. Lewis, *Banach spaces-functional analysis*

Ilya Bakelman, *Geometric inequalities and convex bodies*

Scott T. Chapman and Nick H. Vaughan, *Commutative algebra*

Daniel S. Freed, Robert F. Williams and Michael Wolf, *Texas topology and geometry*

John Leucke and Robert Myers, *Low dimensional topology*

Lisa Mantini and Roger C. Zierau, *Representation theory of Lie groups*

John W. Neuberger and Henry A. Warchall, *Differential equations*

Peter F. Stiller, *Algebraic geometry*

January 1991 Meeting in San Francisco, California

Associate Secretary: Andy Roy Magid

Deadline for organizers: April 16, 1990

Deadline for consideration: September 19, 1990

March 1991 Meeting in South Bend, Indiana

Central Section

Associate Secretary: Andy Roy Magid

Deadline for organizers: June 16, 1990

Deadline for consideration: To be announced

March 1991 Meeting in Tampa, Florida

Southeastern Section

Associate Secretary: Joseph A. Cima

Deadline for organizers: June 22, 1990

Deadline for consideration: To be announced

October 1991 Meeting in Fargo, North Dakota

Central Section

Associate Secretary: Andy Roy Magid

Deadline for organizers: January 25, 1991

Deadline for consideration: To be announced

January 1992 Meeting in Baltimore, Maryland

Associate Secretary: W. Wistar Comfort

Deadline for organizers: April 8, 1991

Deadline for consideration: To be announced

January 1993 Meeting in San Antonio, Texas

Associate Secretary: Lance W. Small

Deadline for organizers: April 13, 1992

Deadline for consideration: To be announced

January 1994 Meeting in Cincinnati, Ohio

Associate Secretary: Joseph A. Cima

Deadline for organizers: April 5, 1993

Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the PCNM from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but can be found in "Rules for Special Sessions" on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the PCNM or by the Associate Secretary. Other

proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the PCNM well in advance of the meeting and, in any case, at least nine months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to Notices or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in *Notices* in such a timely fashion that a member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three weeks before the Deadline for Abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. They are selected by the Section Program Committee. The processing of proposals for Special Sessions for Sectional Meetings is handled by the Associate Secretary for the Section who then forwards the proposals to the Section Program Committee, which makes the final selection of the proposals. Each Invited Speaker at a Sectional Meeting is invited to organize a Special Session. Just as for national meetings, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

Proposals for Special Sessions to the Associate Secretaries

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:
Far Western Section (Pacific and Mountain)

Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
e-mail: g_small@math.ams.com
(Telephone 619-534-3590)

Central Section
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e-mail: g.magid@math.ams.com
(Telephone 405-325-6711)

Eastern Section
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Middletown, CT 06457
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(Telephone 203-347-9411)

Southeastern Section
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Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
e-mail: g.cima@math.ams.com
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has

decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Electronic submission of abstracts is now available to those who use the T_EX typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the Abstracts package, users should be sure to specify whether they want the plain T_EX, A_MS-T_EX, or the L_AT_EX package.

Number of Papers Presented

Joint Authorship

Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting.

An individual may contribute only one abstract by title in any one issue of *Abstracts*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Site Selection for Sectional Meetings

Sectional Meeting sites are recommended by the Associate Secretary for the Section and approved by the Committee of Associate Secretaries and Secretary. Recommendations are usually made eighteen to twenty-four months in advance. Host departments supply local information, ten to twelve rooms with overhead projectors for contributed paper sessions and special sessions, an auditorium with twin overhead projectors for invited addresses, and registration clerks. The Society partially reimburses for the rental of facilities and equipment, and for staffing the registration desk. Most host departments volunteer; to do so, or for more information, contact the Associate Secretary for the Section.

1990 Summer Seminar in Applied Mathematics

Vortex dynamics and vortex methods

University of Washington, Seattle, June 18–29

The twenty-first AMS-SIAM Summer Seminar in Applied Mathematics will be held June 18–29, 1990, at the University of Washington, Seattle. The seminar will be sponsored jointly by the American Mathematical Society and the Society for Industrial and Applied Mathematics (SIAM). It is anticipated that the seminar will be supported by a grant from federal agencies. The proceedings of the seminar will be published by the AMS in the *Lectures in Applied Mathematics* series.

The subject of this seminar will be the study of vorticity-dominated fluid motion. Numerical techniques and their applications will be discussed (in particular, there will be several talks about discrete vortex methods). Applied mathematical analysis and laboratory experiments will be additional lecture subjects. A combination of introductory exposition and recent research results will be presented in the lectures. A goal of the seminar is to bring together researchers with different viewpoints in order to suggest new approaches and to facilitate critical evaluations of existing techniques for the study of vorticity-dominated flows.

A partial list of invited speakers includes J. BELL, Lawrence Livermore National Laboratories; T. BUTTKE, Courant Institute of Mathematical Sciences, NYU; R. CAFLISCH, University of California, Los Angeles; A. J. CHORIN, University of California, Berkeley; W. DAHM, University of Michigan; J. FERZIGER, Stanford University; A. GHONIEM, Massachusetts Institute of Technology; R. GLOWINSKY, University of Houston; W. HENSHAW, IBM T.J. Watson Research Center; H. HORNING, California Institute of Technology; T. HOU, Courant Institute of Mathematical Sciences, NYU; S. HUBERSON, ONERA, France; A.K.M.F. HUSSAIN, University of Houston; R. KRASNY, University of Michigan; J. LASHERAS, University of Southern California; A. MAJDA, Princeton University; P. MARCUS, University of California, Berkeley; S. MAS-GALLIC, Ecole Polytechnique, France; E. MEIBURG, Brown University; J. NEU, University of California, Berkeley; S. ORSZAG, Princeton University; J. SETHIAN, University of California, Berkeley; M. SHELLEY, University of Chicago; and G. TRYGGVASON, University of Michigan.

The Organizing Committee consists of CHRISTOPHER R. ANDERSON, University of California, Los Angeles, co-chair; STEPHEN CHILDRESS, Courant Institute of Mathematical Sciences, NYU; GEORGES HENRI COTTET,

Ecole Polytechnique, Paris; CLAUDE GREENGARD, IBM T.J. Watson Research Center, co-chair; and ANTHONY LEONARD, California Institute of Technology.

A brochure will be available from the AMS office which will include information on accommodations and local information. Participants will be required to pay a \$20 registration fee and a \$25 social fee.

Those interested in attending the seminar should send the following information to the Summer Seminar Conference Coordinator, American Mathematical Society, P.O. Box 6248, Providence, RI 02940; by electronic mail: BAV@MATH.AMS.COM; or by FAX: 401-331-3842 before **March 23, 1990**.

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home. E-mail address (if applicable);
4. Member of AMS or SIAM? Include customer code if an AMS member;
5. Anticipated arrival and departure dates;
6. Your scientific background relevant to the topic;
7. Financial assistance requested (estimate cost of travel);
8. Indicate if interested in attending if support is offered. Indicate if support is not required.

Participants who wish to apply for a grant-in-aid should so indicate; however, funds available for the seminar are very limited and individuals who can obtain support from other sources should do so. Graduate students who have completed at least one year of graduate school are encouraged to participate.

Funds may also be available for foreign graduate students under the Short Term Enrichment Program (STEP) of the United States Information Agency (USIA). Students must meet the following eligibility requirements:

1. must be enrolled in full-time graduate studies at a U.S. institution of higher education;
 2. are not receiving any U.S. government funds for academic support;
 3. are not on refugee, immigrant, or tourist visa status; and
 4. have not been awarded STEP grants previously.
- Eligible students should include the following information when supplying the above eight items: 1. home country; 2. student status; 3. name of institution enrolled; 4. name of an official at the institution who can verify status; and 5. financial situation.

1990 Summer Research Institute

Differential Geometry

University of California, Los Angeles, July 8–28

The thirty-eighth Summer Research Institute sponsored by the American Mathematical Society will be devoted to *Differential Geometry* and will take place at the University of California, Los Angeles. Members of the Organizing Committee are: ROBERT BRYANT, Duke University; EUGENIO CALABI, University of Pennsylvania; S. Y. CHENG, University of California, Los Angeles; H. BLAINE LAWSON, State University of New York, Stony Brook; H. WU, University of California, Berkeley; ROBERT E. GREENE, University of California, Los Angeles (co-chair); and S. T. YAU, Harvard University (co-chair).

It is anticipated that the institute will be partially supported by a grant from the National Science Foundation. Proceedings of the institute will be published in the AMS series *Proceedings of Symposia in Pure Mathematics*.

This topic was selected by the 1988 AMS Committee on Summer Institutes and Special Symposia whose members at the time were: STEVEN L. KLEIMAN (chair), HAYNES R. MILLER, RAGHAVAN NARASIMHAN, PAUL H. RABINOWITZ, THOMAS C. SPENCER, and ROBERT B. WARFIELD, JR..

The years since the last AMS Summer Institute on differential geometry, held in 1973, have been a period of explosive growth and exciting research in this subject. Seen in retrospect, the 1973 institute both recounted the accomplishments in geometry in the 1960's and early 1970's and at the same time marked some new directions for the field. Riemannian geometry in the purest sense along with the theory of characteristic classes in geometry were enjoying a triumphant period. The previous decade had seen the quarter-pinching Sphere Theorem, results on complete open manifolds of nonnegative curvature, the use of heat kernel asymptotics in invariant theory, the discovery of new invariants, and the rapid growth of the theory of foliations. The 1973 institute also heralded a new era just beginning: work on prescribed curvature, the renewed interest in the spectrum of the Laplacian, and the beginning of the study of complex manifolds using analytic $\bar{\partial}$ methods. These were all portents of a new growth period which would involve a vast increase in the use of partial differential equations in geometry.

Partial differential equations arise naturally in geometry. The association of curvature tensor to metric is itself a partial differential operator, which could be thought of as the central object of the whole subject.

Many other operators also arise naturally, as the Euler-Lagrange equations for variational problems. Naturally arising variational problems yield the minimal submanifold equations, the equations for harmonic maps, the complex Monge-Ampere equation for the Ricci curvature of a Kähler manifold, and the Yang-Mills equations. Since the early 1970's, significant progress has been made in understanding all these partial differential equations and many others on manifolds. In a virtually unprecedented way, it has become possible to approach the problems of geometry by direct study of the relevant partial differential equations. The results have transformed the subject of differential geometry.

Any reasonably short list of specific theorems will be necessarily partial, so numerous are the results, but some highlights will help to indicate the magnitude of the progress made: the solution of the Calabi Conjecture on the existence of canonical Einstein-Kähler metrics; the related constructions of a canonical complete Einstein-Kähler metric on pseudoconvex domains in C^n ; the solution of the positive mass conjecture of relativity; the classification of manifolds of positive scalar curvature; results on minimal surfaces in 3-manifolds which were instrumental in the proof of the Smith Conjecture; the use of harmonic maps to prove rigidity theorems for complex manifolds; the characterization of C^n by curvature and related results on gap phenomena for Riemannian manifolds; the development of harmonic function theory on manifolds; the construction of surfaces of constant mean curvature; new results on differential systems; the determination of the possible holonomy groups; the solution of the Frankel conjecture on compact Kähler manifolds of nonnegative bisectional curvature; the solution of the Yamabe problem; the deformation of manifolds of positive Ricci curvature to constant positive; and the existence of canonical metrics on stable vector bundles.

Special mention should be made of the spectacular geometric results arising from Yang-Mills theory. Yang-Mills theory is again an example of an extremal problem, in this case in effect the minimization of the square integral of the curvature of a connection on a principal bundle. When the bundle lies over a 4-dimensional manifold, an additional structural feature arises in that the Hodge star takes the curvature 2-form again to a 2-form, so that 2-forms can be symmetrized and

antisymmetrized relative to this operation. Out of this rich geometric structure arises the possibility of proving profound differential topological results on 4-manifolds by geometric methods. The most spectacular of these is perhaps the existence of "exotic" (nonstandard) differentiable structures on topological R^4 .

There have also been revolutionary developments in Riemannian geometry outside the partial differential equations methods. New concepts and methods involving the limiting behavior of metrics and the structure of the space of Riemannian manifolds as a whole have given new life to manifold geometry. Highlights include: the characterization of almost flat manifolds; the bounds on the Betti numbers of manifolds of nonnegative curvature; finiteness and convergence theorems for manifolds satisfying curvature bounds; and a comprehensive theory of manifolds of negative curvature.

The general intention for the 1990 Summer Institute is to cover not only developments in differential geometry itself, but also related topics in other parts of mathematics and in physics. The planned format is to have a number of one hour survey lectures in the morning sessions offering more broadly sketched viewpoints, followed in the afternoons by shorter, more specialized seminar lectures in parallel sessions. For organizational purposes the subject will be divided into eight subdivisions: 1. Riemannian geometry; 2. Minimal submanifolds; 3. Complex geometry and L^2 cohomology; 4. General theory of partial differential equations on manifolds: harmonic functions and mappings, Monge-Ampere equation, differential systems, and isometric embedding; 5. Eigenvalues, heat flow, and index theory; 6. Gauge theory and geometry in mathematical physics; 7. Groups and manifolds, and dynamical systems; 8. Symplectic geometry.

While it is anticipated that seminar activity on all these topics will continue throughout the three weeks of the institute, each week will have a different specific emphasis on two or more of the eight topics. A tentative list of the topics to be addressed follows.

Week One: July 8 - 14: Minimal submanifolds; general theory of partial differential equations on manifolds; eigenvalues, heat flow and index theory.

Week Two: July 15 - 21: Gauge theory and geometry in mathematical physics; symplectic geometry; complex geometry and L^2 cohomology.

Week Three: July 22 - 28: Riemannian geometry; groups and manifolds, and dynamical systems.

A partial list of survey lecturers includes: (week one) S. S. CHERN, Z. GAO, R. HAMILTON, J. JOST, P. LI, R. SCHOEN, W. WEEKS, H. WENTE; (week two) J. BISMUT,

R. BOTT, N. HITCHIN, J. MILLSON, I. SINGER, M. STERN, C. TAUBES, A. WEINSTEIN; (week three) W. BALLMAN, J. CHEEGER, P. EBERLEIN, T. FARRELL, D. GROMOLL, J. GROVE, P. PETERSEN, D. SULLIVAN.

Accommodations will be available in the campus residence halls for participants; cafeteria style meals will be available. All facilities will be accessible to the handicapped.

Information on housing, dining, travel and the local area will be sent to invited participants in the spring. Each participant will pay a registration fee and a social fee to cover the costs of social events scheduled during the institute.

Those interested in receiving an invitation to participate in the institute should send the following information to the Summer Institute Conference Coordinator, American Mathematical Society, Post Office Box 624, Providence, RI 02940, **prior to April 1, 1990** or through electronic mail: WSD@MATH.AMS.COM, or by FAX 401-331-3842.

Please type or print the following:

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Which week or weeks you wish to attend;
5. Your scientific background relevant to the institute topic;
6. Financial assistance requested;
7. Indicate if interested in attending if support is offered. Indicate if support is not required.
8. If member of AMS, give AMS member code.

Funds may also be available for foreign graduate students under the Short Term Enrichment Program (STEP) of the United States Information Agency (USIA). Students must meet the following eligibility requirements: 1. must be enrolled in full-time graduate studies at a U.S. institution of higher education; 2. are not receiving any U.S. government funds for academic support; 3. are not on refugee, immigrant, or tourist visa status; and 4. have not been awarded STEP grants previously. Those eligible should include the following information when supplying the above eight items: 1. home country; 2. student status; 3. name of institution enrolled; 4. name of an official at the institution who can verify status; and 5. financial situation.

Requests for invitations will be forwarded to the Organizing Committee for consideration up to the deadline of **April 1**, and applicants selected will receive their invitations and notification of financial assistance beginning in mid-May.

Symposium on Some Mathematical Questions in Biology

Neural Networks

Vancouver, Canada, August 2-3

The twenty-fourth annual Symposium on Some Mathematical Questions in Biology on *Neural networks* will be held on Thursday and Friday, August 2-3, 1990, during the Congress of the International Union for Pure and Applied Biophysics (IUPAB), July 29-August 3, 1990. The symposium is sponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics (SIAM), and the Society for Mathematical Biology (SMB).

The AMS-SIAM-SMB Committee on Mathematics in the Life Sciences serves as the Organizing Committee for the symposium. The committee consisted of Jack D. Cowan (organizer), Michael C. Mackey, Marc Mangel, Hans G. Othmer, Richard E. Plant (chairman), and John Rinzel.

The theme of the symposium is *Neural networks*. There will be two morning sessions on Thursday and Friday, August 2 and 3, each including three one-hour lectures.

For further information, contact the Symposium Conference Coordinator, AMS, P.O. Box 6248, Providence, RI 02940 or by electronic mail: BAV@MATH.AMS.COM.

Program

Thursday, August 2, 9:30 a.m.

Chairman: Robert Miura, University of British Columbia

Neurodynamics. JACK D. COWAN, University of Chicago

Learning, networks, and approximation theory. T. A. POGGIO, Massachusetts Institute of Technology

Neural networks, information theory and perception, in animals and machines. RALPH LINSKER, IBM T. J. Watson Research Center

Friday, August 3, 9:30 a.m.

Chairman: John Rinzel, National Institutes of Health

Learning and generalization in multi-layered neural networks: A statistical analysis. D. RUMELHART, Stanford University

Growing and pruning neural networks: relation to statistical mechanics. ALAN LAPEDES, Los Alamos National Laboratory

Perspectives in computational neurobiology. TERRENC J. SEJNOWSKI, Salk Institute

Joint Summer Research Conference in the Mathematical Sciences

University of Massachusetts at Amherst
June 7-13, 1990

Inverse scattering and applications

In previous issues of the *Notices*, the title of this conference was given incorrectly as *Inverse scattering on the line*. The correct title is *Inverse scattering and applications*.

There has been much progress recently on inverse scattering theory in one and two dimensions. This conference will cover recent developments in the field, including inverse scattering theory on the line, Riemann-Hilbert problems, and inverse monodromy problems. Multidimensional problems will be covered, using the so-called $\bar{\partial}$ methods. Applications to the Davey-Stewartson II and KP II equations will be treated. Higher dimensional problems will also be discussed, and one day will be spent on applications of inverse scattering theory and inverse monodromy theory to problems in statistical mechanics.

Members of the Organizing Committee: RONALD R. COIFMAN (Yale University), CRAIG A. TRACY (University of California, Davis) and STEPHANOS VENAKIDES (Duke University).

The deadline for receipt of applications for this conference has been extended to **March 23, 1990**. For more information on the conferences, please refer to the 1989 October and November issues of the *Notices* or contact the Summer Research Coordinator, Meetings Department, American Mathematical Society, Post Office Box 6248, Providence, RI 02940 or by E-Mail: CAK@MATH.AMS.COM on the Internet.

Call For Topics For 1992 Conferences

Suggestions are invited from mathematicians, either singly or in groups, for topics of the various conferences that will be organized by the Society in 1992. The deadlines for receipt of these suggestions, as well as some relevant information about each of the conferences, are given below. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, or telephoning 401-455-4146, or sending E-mail to MEET@MATH.AMS.COM.

Individuals willing to serve as organizers should be aware that the professional meetings staff in the Society's Providence office will provide full support and assistance before, during, and after each of these conferences. Organizers should also note that for all conferences, except Summer Research Conferences, it is required that the proceedings be published by the Society, and that proceedings of Summer Research Conferences are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and the chairman of the Organizing Committee; (2) a one- to two-page description addressing the focus of the topic including the importance and timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; and (5) a list of likely candidates who would be invited to participate and their current affiliations. Any suggestions as to sites and dates should be made as early as possible in order to allow adequate time for planning. However, proposers of conferences should know that, by action of the AMS Board of Trustees, the Meetings Department of the Society is responsible for the final selection of the site for each conference and for all negotiations with the host institution. Individuals submitting suggestions for the conferences listed below are requested to recommend sites or geographic areas which would assist the Meetings Department in their search for an appropriate site. In the case of Joint Summer Research Conferences in the Mathematical Sciences, a one-, two-, or three-week conference may be proposed.

1992 AMS Symposium in Pure Mathematics

The symposium in pure mathematics has traditionally been conducted in the spring of even-numbered years in conjunction with a sectional meeting. The symposium can be held independently of a sectional meeting and serves to honor great accomplishments in mathematics. Proceedings are normally published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Topics in recent years have been:

1984 - *Pseudodifferential operators and Fourier integral operators with applications to partial differential equations*, organized by FRANÇOIS TREVES of Rutgers University

1987 - *The mathematical heritage of Herman Weyl*, organized by R. O. WELLS, JR. of Rice University.

1989 - *Complex geometry and Lie theory*, organized by JAMES CARLSON and C. HERBERT CLEMENS, University of Utah.

Deadline For Suggestions: September 1, 1990

1992 AMS Summer Institute

Summer institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics and usually extend over a three-week period. Dates for a summer institute must not overlap those of the Society's summer meetings which at the time of this printing have not yet been determined. There should be a period of at least one week between them. Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Current and recent topics:

1988 - *Operator theory/Operator algebras and applications*, organized by WILLIAM B. ARVESON of University of California, Berkeley, and RONALD G. DOUGLAS of State University of New York at Stony Brook.

1989 - *Several complex variables and complex geometry*, organized by STEVEN G. KRANTZ of Washington University.

1990 - *Differential geometry*, organized by ROBERT GREENE of University of California, Los Angeles, and SHING-TUNG YAU of Harvard University.

Deadline For Suggestions: September 1, 1990

1992 AMS-SIAM-SMB Symposium Some Mathematical Questions in Biology

This one-day symposium, sponsored jointly by the AMS, the Society for Industrial and Applied Mathematics, and the Society for Mathematical Biology, is usually held in conjunction with the annual meeting of a biological society closely associated with the topic. Papers from the symposia are published by the AMS as volumes in the series *Lectures on Mathematics in the Life Sciences*.

Current and recent topics:

1987—*Models in population biology*, organized by ALAN HASTINGS of the University of California, Davis.

1988—*Dynamics of excitable media*, organized by HANS G. OTHMER of the University of Utah.

1989—*Sex allocation and sex change: Experiments and models*, organized by MARC MANGEL of the University of California, Davis.

1990—*Neural Networks*, organized by JACK D. COWAN of the University of Chicago.

Deadline For Suggestions: September 1, 1990

1992 AMS-IMS-SIAM Joint Summer Research Conferences in the Mathematical Sciences

These conferences, jointly sponsored by the AMS, the Institute for Mathematical Statistics, and the Society for Industrial and Applied Mathematics, are similar in structure to those held at Oberwolfach and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. Topics for the seventh series of one-week conferences, being held in 1990, are: *Probability models and statistical analysis for ranking data*; *Inverse scattering on the line*; *Deformation theory of algebras and quantization with applications to physics*; *Strategies for sequential search and selection in real time*; *Schottky Problems*; and *Logic, local fields, and subanalytic sets*.

If proceedings are published by the AMS, they will appear as volumes in the series *Contemporary Mathematics*.

Deadline For Suggestions: February 1, 1991

1992 AMS-SIAM Summer Seminar

The goal of the summer seminar, sponsored jointly by the AMS and the Society for Industrial and Applied Mathematics, is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the AMS as volumes in the series *Lectures in Applied Mathematics*.

Current and recent topics:

1987—*Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation*, organized by RANDOLPH BANK of the University of California, San Diego.

1988—*Computational solution of nonlinear systems of equations*, organized by EUGENE ALLGOWER of Colorado State University.

1989—*The mathematics of random media*, organized by WERNER KOHLER of Virginia Polytechnic Institute and BENJAMIN WHITE of Exxon Research & Engineering Company.

1990—*Vortex dynamics and vortex methods*, organized by CLAUDE GREENGARD of IBM T. J. Watson Research Center and CHRISTOPHER R. ANDERSON of University of California, Los Angeles.

Deadline For Suggestions: September 1, 1990

Call for Topics for

1992 AMS Short Course Series

The AMS short courses consist of a series of introductory survey lectures and discussions ordinarily extending over a period of one-and-one-half days starting immediately prior to the Joint Mathematics Meetings held in January and August each year. Each theme is a specific area of applied mathematics or mathematics used in the study of a specific subject or collection of problems in one of the physical, biological, or social sciences, technology, or business.

Current and recent topics:

Combinatorial games (August 1990), *Mathematical questions in robotics* (January 1990), *Cryptology and computational number theory* (August 1989), *Matrix theory and applications* (January 1989), *Chaos and fractals* (August 1988), *Computational Complexity Theory* (January 1988). Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Applied Mathematics*, with the approval of the Editorial Committee.

Deadline for Suggestions: Suggestions for the January 1992 course should be submitted by July 1, 1990; suggestions for the August 1992 course should be submitted by December 1, 1990.

Submit suggestions to: James W. Maxwell, AMS, P.O. Box 6248, Providence, RI 02940.

Mathematical Sciences Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

EFFECTIVE with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.

1989-1990. **Academic Year Devoted to Hyperbolic Geometry and Quasiconformal Mappings**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1988, p. 1584)

1989-1990. **Special Year in Geometry**, University of Maryland, College Park, MD. (Dec. 1989, p. 1432)

PROGRAM: The Dept. of Math. of the Univ. of Pisa and the Scuola Normale Superiore will organize in the spring term 1990 a special semester to honour the memory of Aldo Andreotti. The semester will be mainly dedicated to algebraic geometry, complex analysis, analytic geometry and partial differential equations.

INVITED SPEAKERS: W. Barth, A. Beauville, E. Bierstone, J.E. Björk, E. Bombieri, F. Campana, A. Douady, H. D'Souza, T. Frankel, H. Grauert,

P.A. Griffiths, M. Gromov, N. Ivancevich, S. Klainerman, J.J. Kohn, D. Laksov, Lê Dũng Tráng, S. Łojasiewicz, Malgrange, P. Milman, S. Mizoguchi, R. Narasimhan, L. Nirenberg, F. Oprea, M. Seppälä, M. Shiota, M. Schneider, M. Spivakovsky, W.F. Stoll, G. V. der Geer, S.S.T. Yau, S.T. Yau.
INFORMATION: Semestre Andreotti, M. Galbiati, Dipartimento di Matematica - Università di Pisa, Via Buonarroti, 2 56127 Pisa - Italy; email: galbiati@icnucevm.bitnet.

1990. **IMACS International Workshop on Massively Parallel Methods in Computational Physics**, Boulder, Colorado. (Sep. 1989, p. 914)

1990. **IMACS Conference on Computer Aided Design**, Yugoslavia. (Sep. 1989, p. 914)

1990. **CWI-IMACS Symposia on Parallel Scientific Computing**, Amsterdam, The Netherlands. (Feb. 1990, p. 216)

1990-1991. **Academic Year Devoted to Operator Theory and Complex Analysis**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1989, p. 1432)

March 1990

*19-23. **DIMACS Workshop: Arrangements, Center for Discrete Mathematics and Theoretical Computer Science**, Brunswick, NJ.

PROGRAM: This is the fourth workshop in the DIMACS Special Year on Discrete and Computational Geometry. The plan is to have a small number of invited and contributed talks in order to encourage more interaction among the participants.
ORGANIZERS: R. Pollack, W. Steeger
INVITED SPEAKERS: A. Björner, R. Edelsbrunner, Univ. of Illinois, Goodman, City Univ. of NY, Grünbaum, Univ. of Washington, Mnëv, Leningrad State Univ., P. Shor, New York Univ., M. Sharir, Tel Aviv Univ., P. Shor, AT&T Bell Labs
INFORMATION: DIMACS, Hill Campus, Busch Campus, Rutgers Univ., Box 1179, Piscataway, NJ 08855-1179; 932-5928; toci@dimacs.rutgers.edu

*Spring Term 1990. **Aldo Andreotti Special Semester in Pisa**, Pisa, Italy.

*28-30. **Sixth British Colloquium**

Theoretical Computer Science, Univ. of Manchester, Manchester, England.

PROGRAM: The colloquium aims to provide a forum for theoreticians to learn of new developments in areas including logic and semantics of programs, formal methods, term rewriting, specification and verification, logic and functional programming, data structures, algorithms and complexity, computational algebra, cryptography, parallel computation and models of concurrency, formal languages and type theories, and artificial intelligence.

ORGANIZING COMMITTEE: J. Tucker, Swansea; M. Jerrum, Edinburgh; J. Shawe-Taylor, R.H.B.N.C.; D. Rydeheard, Manchester; P. Dunne, Liverpool; M. Paterson, Warwick; B. Thompson, Swansea; A. Gibbons, Warwick; H. Simmons, Aberdeen.

INFORMATION: BCTCS6, Dept. of Comp. Sci., Univ. of Manchester, Manchester M13 9L, U.K. email:

JANET: bctcs6@uk.ac.man.cs;
BITNET: bctcs6@cs.man.ac.uk;
ARPA: bctcs6@cs.man.ac.uk
or bctcs%cs.man.ac.uk@nsfnet-relay.ac.uk.

30-31. **Sixth Pacific Coast Gravity Meeting**, Univ. of Oregon, Eugene, OR.

INFORMATION: T. Dray (tevisan@math.orst.edu) or J. Isenberg (Institute of Theoretical Science, Univ. of Oregon, Eugene, OR 94703).

31. **Thirty-fifth Algebra Day**, Univ. of Ottawa, Ottawa Ontario, Canada.

SPONSORS: Carleton Univ. and Univ. of Ottawa.

INVITED SPEAKERS: G. Benkart, Wisconsin; B. Fine, Fairfield; O. Mathieu, IAS/Paris.

INFORMATION: M. Racine, Dept. of Math., Univ. of Ottawa, Ottawa Ontario K1N 6N5, Canada.

April 1990

3. **Low Dimensional Dynamics**, University of Maryland at College Park. (Jan. 1990, p. 54)

1-4. **ENAR Spring Meeting**, Baltimore, MD. (Jul./Aug. 1989, p. 766)

1-7. **Design and Codes**, Oberwolfach, Federal Republic of Germany. (Jul./Aug.

1989, p. 766)

1-14. **NATO Advanced Study Institute on "Generators and Relations in Groups and Geometries"**, Castelveccchio Pascoli (Lucca), Italy. (Sep. 1989, p. 916)

3-4. **Mathematics in a Changing Culture**, Glasgow College, Glasgow, Scotland. (Jan. 1990, p. 54)

3-5. **Forty-second British Mathematical Colloquium**, University of East Anglia, Norwich, Norfolk, England. (Jan. 1990, p. 54)

4-7. **Symposium on Distributions with Given Marginals (In Memory of Giuseppe Pompilj)**, Rome, Italy. (Oct. 1989, p. 1095)

5-7. **Twenty-fourth Annual Spring Topology Conference**, Southwest Texas State Univ., San Marcos, TX. (Nov. 1989, p. 1249)

5-8. **Conference on Algebraic K-theory and Algebraic Number Theory**, Johns Hopkins Univ., Baltimore, MD. (Jan. 1990, p. 54)

7-8. **Eastern Section Meeting of the AMS**, Pennsylvania State University, University Park, PA. (Note change in date from Oct. 1989, p. 1095)

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

7-8. **1990 Association for Symbolic Logic Spring Meeting (in conjunction with a Spring meeting of the AMS and a MAMLS meeting)**, Pennsylvania State University, University Park, PA. (Feb. 1990, p. 217)

* 7-9. **History in Mathematics Education**, Univ. of Leicester, Leicester, England.

PROGRAM: The format is a mixture of talks, from teachers in this country and abroad who have developed historical perspectives in their mathematics teaching, and workshop sessions to consolidate and develop the ideas further. The conference is not about teaching the history of mathematics as a school subject, but about using history in mathematics teaching.

INFORMATION: S. Russ, HIMED 90, Dept. of Comp. Sci., Univ. of Warwick, Coventry CV4 7AL; tel (0203) 523681.

* 8-11. **Symposium on the Inverse Galois Problem**, Oxford, England.

PURPOSE: The symposium will be held

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to coincide with W. Feit's arrival for a two month visit. The aim of the symposium will be to survey what has been achieved and where future work should be directed on the Inverse Galois Problem.

INVITED SPEAKERS: W. Feit, B.H. Matzat, G. Malle, J.-P. Serre, J.G. Thompson, L.L. Scott, J.A. Green.

INFORMATION: M.J. Collins, Mathematical Institute, Oxford Univ., 24-29 St. Giles', Oxford, OX1 3LB.

8-12. **Gamm-Jahrestagung**, Hannover, Federal Republic of Germany. (Jan. 1990, p. 54)

8-14. **Arbeitsgemeinschaft Mit Aktuellem Thema (wird in den Mitteilungen der DMV Heft 1/1990 bekanntgegeben)**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

9-13. **Fifth Workshop on Mathematical Aspects of Computer Science**, Mägdelsprung, German Democratic Republic. (Nov. 1989, p. 1249)

15-21. **Mathematical Concepts of Dependable Systems**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

16-20. **Using Algebraic Processors in Dynamical Systems**, University of Minnesota, Minneapolis, MN. (Feb. 1990, p. 217)

17-21. **Phenomenes de Stokes et Resurgence**, Marseille, France. (Jan. 1990, p. 54)

17-21. **International Conference on Effective Methods in Algebraic Geometry**, Castiglioncello (near Pisa), Italy. (Feb. 1990, p. 217)

18-20. **Biological Fluid Dynamics Workshop**, Pittsburgh Supercomputing Center, Pittsburgh, PA. (Feb. 1990, p. 218)

18-21. **Sixty-eighth Annual Meeting of the National Council of Teachers of Mathematics**, Salt Lake City, UT. (Jul./Aug. 1989, p. 766)

19-21. **Fourth National Conference on Undergraduate Research**, Union College, Schenectady, NY. (Nov. 1989, p. 1249)

19-21. **Conference on Function Spaces**, Southern Illinois University, Edwardsville, IL. (Dec. 1989, p. 1435)

19-22. **1990 Far Western Section**, University of New Mexico, Albuquerque, New Mexico.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

- 22-25. **Directions for the Decade in SUPERcomputing**, University of Florida, Gainesville, FL. (Jan. 1990, p. 54)
- 22-27. **Tenth Conference on Analytic Functions**, Kozubnik, Poland. (Oct. 1989, p. 1095)
- 22-28. **Einhollende Algebren und Ringe Von Differentialoperatoren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)
- 24-26. **Second IMACS/ACM-SIGNUM International Conference on Expert Systems for Numerical Computing**, Purdue University, West Lafayette, Indiana. (Feb. 1990, p. 218)
- 27-30. **Conference on Geometry and Topology**, Harvard University, Cambridge, MA. (Feb. 1990, p. 218)
- 28-29. **Symposium on Value Distribution Theory in Several Complex Variables**, Univ. of Notre Dame, Notre Dame, Indiana. (Nov. 1989, p. 1250)
- 29-May 5. **Gruppentheorie (Pro-Endliche Gruppen)**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)
- 30-May 4. **Mathematiques pour la Robotique**, Marseille, France. (Jan. 1990, p. 54)

May 1990

- 3-4. **Twenty-first Annual Pittsburgh Conference on Modeling and Simulation**, University of Pittsburgh, Pittsburgh, PA. (Sep. 1989, p. 916)
- * 3-4. **Automation and Information Engineering Annual Research Review Conference**, College Park, MD.

SPONSORS: The Systems Research Center of the Univ. of Maryland and Harvard Univ.

CONFERENCE TOPICS: Intelligent servomechanisms, expert systems and parallel architectures, chemical process systems, manufacturing systems, communications and signal processing systems.

INVITED SPEAKER: G. Larrabee.

INFORMATION: Registration Deadline is April 15. S. Dass, Systems Research Center, A.V. Williams Bldg. (115), Univ. of Maryland, College Park, MD 20742; tel 301-454-7986.

- * 4. **Second Conference on Mathematical Biology**, Stony Brook, NY.

PURPOSE: The conference is intended to provide workers at the interface of mathematics and biology with an opportunity to discuss issues of common interest.

PROGRAM: In addition to two invited talks by J. Cowan and J. White, there will be a series of short talks morning and afternoon.

INFORMATION: E. Beltrami, Dept. of Applied Math. and Stat., State Univ. of New York at Stony Brook, NY 11794-3600; tel 516-632-8367; email: beltrami@chaos.sunysb.edu.

- 5-6. **Pacific Northwest Geometry Seminar**, University of Oregon, Eugene, OR. (Jan. 1990, p. 55)

- * 5-6. **Midwest Partial Differential Equations Seminar**, Northwestern Univ., Evanston, IL.

INFORMATION: Contact A. Devinatz at the address above.

- 6-9. **Computer Algebra and Differential Equations (CADE-90)**, Cornell University, Ithaca, NY. (Feb. 1990, p. 218)

- 6-12. **Geschichte der Mathematik**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- 7-9. **1990 IEEE Symposium on Research in Security and Privacy**, Oakland, CA. (Oct. 1989, p. 1095)

- * 7-9. **Geometric Modeling and Design**, Wayne State Univ., Detroit, MI.

CONFERENCE TOPICS: Continuity of parametric surface patches, algebraic geometry in geometric modeling and design, NC machining and toolpath planning.

INVITED SPEAKERS: C. Chui, G. Farin, D. Gossard, C. Hoffman, A. Requicha.

INFORMATION: T.C. Sun, Dept. of Mathematics, Wayne State Univ., Detroit, MI 48202; tel 313-577-2499; email: tsun@waynest1.bitnet.

- 7-10. **SIAM Conference on Applications of Dynamical Systems**, Orlando, FL. (Sep. 1989, p. 916)

- 7-11. **Recent Advances in Regression**, Montréal, Canada. (Jan. 1990, p. 55)

- 7-11. **Algorithmes et Programmation**, Marseille, France. (Jan. 1990, p. 55)

- 7-11. **Statistics Week**, Université de Montréal, Canada. (Feb. 1990, p. 218)

- 7-11. **College on Recent Develop-**

ments and Applications in Mathematics and Computer Science, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 601)

- 9-12. **Computer Algebra and Parallelism (CAP-90)**, Cornell University, Ithaca, NY. (Feb. 1990, p. 218)

- 13-19. **Abstrakte Konvexe Analyse**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

- * 14-15. **Finite Element Applications in Computational Mechanics**, Champaign, IL.

SPONSOR: The National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign (UIUC).

INFORMATION: I. Dilber, NCSA, Computing Applications Building, 618 East Springfield Ave., Champaign, IL 61820; tel: 217-244-1973; email: idilber@ncsa.uiuc.edu (Internet: 13024@ncsavms (Bitnet)).

- 14-15. **Regional Workshop on Nonlinear Conservation Laws**, Stony Brook, NY. (Jan. 1990, p. 55)

- * 14-18. **Conference on Nonlinear Analysis and Partial Differential Equations**, Rutgers University, New Brunswick, NJ. (Please note change from Jul./Aug. 1989, p. 767)

INFORMATION: H.F. Pirrello, Conference on Nonlinear Analysis, Dept. of Math., Hill Center, Rutgers University, New Brunswick, NJ 08903; email: pirrello@math.rutgers.edu.

- 14-18. **Workshop on K-Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 55)

- 14-18. **Singularities et Theorie de Hodge**, Marseille, France. (Jan. 1990, p. 55)

- * 14-18. **Surfaces, Submanifolds, and Applications**, Univ. of Leeds, Leeds, England.

INVITED SPEAKERS: B.-Y. Chen, N. Gan, J. Eells, Warwick; H. Kato, Bonn; K. Nomizu, Brown; U. Pinkall, Berlin; B. Smythe, Notre Dame; Verstraeten, Leuven; M. Bloor, Leuven; A. West. INFORMATION: Mathematics Department, Univ. of Leeds, Leeds LS2 9JT; email: pmt6aw@uk.ac.leeds.ucs.cmsl; (0532) 335154.

- 17-19. **Interface '90 (formerly Comput-**

Science and Statistics: Symposium on Interface, East Lansing, MI. (Sep. 1989, p. 916)

17-19. **Colloquium: Computer Graphics in Pure Mathematics**, University of Iowa, Iowa City, IA. (Dec. 1989, p. 1435)

18-20. **Nineteenth Annual State of Jefferson Mathematics Congress**, Whiskeytown, CA. (Feb. 1990, p. 219)

20-23. **1990 International Industrial Engineering Conference**, San Francisco, CA.

PROGRAM: The annual conference will bring together the most successful professionals in the field to share state of the art techniques, methods, and theories. The educational program will feature over 100 education sessions, 8 pre-conference seminars, and 6 evening workshops.

INFORMATION: IIE Registrar, P.O. Box 6150, Norcross, GA 30091-6150; tel 404-449-0460; Fax 404-263-8532.

20-25. **NSF/CBMS Conference on Operator Algebras**, Texas Christian University, Fort Worth, TX. (Jan. 1990, p. 55)

20-26. **The Schrödinger Equation and Its Classical Counterparts**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

21-24. **The Simulation of Random Processes and Fields - Mathematics and Applications**, Portofino, Italy. (Sep. 1989, p. 916)

21-25. **NSF-CBMS Regional Conference on The Interface between Analytic Number Theory and Harmonic Analysis**, Manhattan, KS. (Jan. 1990, p. 55)

21-25. **Eleventh United States National Congress of Applied Mechanics**, Tucson, AZ. (Nov. 1988, p. 1389)

21-25. **Nonlinear Analysis, Function Spaces and Applications IV**, Czechoslovakia. (Jan. 1990, p. 56)

21-25. **DIMACS Workshop: Algebraic Issues in Geometric Computations**, New Brunswick, NJ.

PROGRAM: This is the sixth workshop in the DIMACS Special Year on Discrete and Computational Geometry. The plan is to have a number of invited and contributed talks, in order to encourage more direct interaction among the participants.

ORGANIZERS: R. Pollack, B. Sturmfels.

INVITED SPEAKERS: S. Abhyankar, Purdue Univ.; P. Alfeld, Univ. of Utah;

D. Arnon, Xerox, Palo Alto; C. Bajaj, Purdue Univ.; D. Bayer, Columbia Univ.; L.J. Billera, Cornell Univ.; B. Buchberger, Linz, Austria; J. Canny, Berkeley; D. Kozen, Cornell Univ.; J. Renegar, Cornell Univ.; M.-F. Roy, Rennes, France; J.-J. Risler, Paris; D. Scott, Carnegie-Mellon Univ.; M. Sharir, Tel Aviv.

INFORMATION: DIMACS, Hill Center, Busch Campus, Rutgers Univ., P.O. Box 1179, Piscataway, NJ 08855; 201-932-5928; toci@dimacs.rutgers.edu.

23-25. **1990 International Symposium on Multiple-Valued Logic**, Charlotte, NC. (Apr. 1989, p. 496)

23-25. **Workshop on Viscous and Numerical Approximation of Shock Waves**, North Carolina State University, Raleigh, NC. (Feb. 1990, p. 219)

23-27. **Azumaya Algebras, Group Actions, and Modules: A Conference in Honor of Goro Azumaya's 70th Birthday**, Indiana University, Bloomington, IN. (Feb. 1990, p. 219)

24. **Second Conference on Lagrange Calculus**, Community College of Philadelphia, Philadelphia, PA. (Feb. 1990, p. 219)

24-25. **Twelfth Symposium on Mathematical Programming with Data Perturbations**, George Washington Univ., Washington, DC. (Nov. 1989, p. 1250)

24-26. **Conference on Probability Models in Mathematical Physics**, Colorado Springs, CO. (Jan. 1990, p. 56)

25-31. **Tenth International Conference on Pattern Recognition**, Resorts Hotel, Atlantic City, NJ. (Mar. 1988, p. 466)

27-June 2. **Lyapunov-Exponents**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

28-June 1. **Twenty-second Annual Conference on Statistics**, Tours, France. (Jan. 1990, p. 56)

28-June 1. **Tenth International Conference on Distributed Computing Systems**, Paris, France. (Jan. 1990, p. 56)

28-June 1. **Mecanique Celeste et Systemes Hamiltoniens**, Marseille, France. (Jan. 1990, p. 56)

28-June 1. **Workshop on Set Theoretic Methods in Algebra**, Baylor University, Waco, Texas. (Feb. 1990, p. 219)

28-June 2. **Geometry of Complex Projective Varieties**, Cetraro, Italy. (Nov. 1989, p. 1250)

29-30. **Algebraic Logic Conference in Honour of Professor Don Monk**, Boulder, Colorado. (Nov. 1989, p. 1250)

29-31. **GAMM/IFIP Workshop: "Stochastic Optimization: Numerical Methods and Technical Applications"**, Neubiberg, Federal Republic of Germany. (Jan. 1990, p. 56)

29-June 1. **Eleventh Annual Conference of the Canadian Applied Mathematics Society**, Halifax, Nova Scotia. (Oct. 1989, p. 1096)

29-June 2. **Dynamical Theories of Turbulence in Fluid Flows**, Minneapolis, MN. (Nov. 1989, p. 1250)

29-June 2. **Workshop on Dynamical Systems in Fluid Mechanics**, Minneapolis, MN. (Nov. 1989, p. 1251)

30-31. **Conference on Algebraic Logic**, Boulder, Colorado. (Dec. 1989, p. 1436)

31-June 1. **Annual Meeting of the Canadian Society for History and Philosophy of Mathematics**, University of Victoria, British Columbia. (Feb. 1990, p. 220)

31-June 3. **Percolation Models of Material Failure**, Cornell University, Ithaca, NY. (Dec. 1989, p. 1436)

June 1990

June-July 1990. **International IMACS Conference on Mathematical Modelling and Applied Mathematics**, Vilnius, USSR. (Sep. 1989, p. 917)

1-8. **Third International Symposium on Orthogonal Polynomials and Their Applications**, Erice-Trapani (Sicily), Italy. (Dec. 1989, p. 1436)

1-10. **Fourth Annual Meeting of the International Workshop in Analysis and its Applications**, Dubrovnik-Kupari, Yugoslavia. (Oct. 1989, p. 1096)

3-6. **1990 Annual Meeting of the Statistical Society of Canada**, St. John's, Newfoundland, Canada. (Sep. 1989, p. 917)

3-6. **Symposium on Chaos in Biological and Agricultural Systems**, Lincoln, Nebraska. (Jan. 1990, p. 56)

3-9. **Graphentheorie**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

4-7. **Fifth Annual IEEE Symposium on Logic in Computer Science**, Philadelphia, PA. (Sep. 1989, p. 917)

4-8. **Workshop on Model Theory**, Berkeley, CA. (Sep. 1989, p. 917)

- 4-8. **Nonlinear Phenomena in Atmospheric and Oceanic Sciences**, Minneapolis, MN. (Nov. 1989, p. 1251)
- 4-8. **International Conference on Approximation Interpolation and Summability in Honor of A. Jakimovski**, Tel Aviv, Israel. (Dec. 1989, p. 1436)
- 4-8. **International Conference on Bootstrapping and Related Techniques**, Trier, Federal Republic of Germany. (Jan. 1990, p. 56)
- *4-8. **The Mathematics of Neural Nets**, Salisbury State Univ., Salisbury, MD.
- PURPOSE: To give college teachers a working knowledge of Neural Nets.
LECTURER: R.J. Scott.
INFORMATION: B.A. Fusaro, Dept. of Math. Sciences, Salisbury State Univ., Salisbury, MD 21801; 301-543-6470 or 6471.
- 4-12. **Recent Developments in Geometric Topology and Related Topics**, Villa "La Querceta", Montecatini Terme. (Feb. 1990, p. 220)
- 4-15. **Analyse Harmonique sur Les Groupes Reductifs P-Adiques**, Marseille, France. (Jan. 1990, p. 56)
- 4-28. **Supercomputing Program for Undergraduate Research**, Cornell National Supercomputing Facility, Ithaca, NY. (Feb. 1990, p. 220)
- 6-8. **First IFIP Conference on Fractals**, Lisbon, Portugal. (Jan. 1990, p. 57)
- 6-9. **Fifth Annual Conference of the European Consortium for Mathematics in Industry**, Lahti, Finland. (Apr. 1989, p. 496)
- 6-12. **1990 Barcelona Conference on Algebraic Topology**, Centre de Recerca Matematica, Barcelona, Spain. (Sept. 1988, p. 1060)
- 6-15. **Third Logical Biennial (in honour of S.C. Kleene)**, Chaika (near Varna), Bulgaria. (Oct. 1989, p. 1096)
- 7-July 4. **1990 Joint Summer Research Conferences in the Mathematical Sciences**, University of Massachusetts at Amherst, MA.
- INFORMATION: C. Kohanski, AMS, P.O. Box 6248, Providence, RI 02940.
- 10-14. **Sixth Haifa Matrix Conference**, Technion City, Haifa, Israel. (Feb. 1990, p. 220)
- 10-16. **Reelle Algebraische Geometrie**, Oberwolfach, Federal Republic of Ger-

- many. (Jul./Aug. 1989, p. 767)
- 10-16. **Fourth Czechoslovak Symposium on Combinatorics**, Prachtice, Czechoslovakia. (Nov. 1989, p. 1251)
- 11-14. **Fourteenth Rolf Nevanlinna Colloquium**, University of Helsinki, Helsinki, Finland. (Jul./Aug. 1989, p. 767)
- 11-14. **Fifth SIAM Conference on Discrete Mathematics**, Atlanta, GA. (Sep. 1989, p. 917)
- 11-15. **World Organization of Systems and Cybernetics Eighth International Congress**, New York, NY. (Please note date change from Mar. 1989, p. 315)
- 11-15. **Chaotic Processes in the Geological Sciences**, Minneapolis, MN. (Nov. 1989, p. 1251)
- 11-15. **Third International Conference on Hyperbolic Problems**, Uppsala, Sweden. (Jan. 1990, p. 57)
- 11-15. **Rigorous Results in Quantum Dynamics**, Liblice Castle, Czechoslovakia. (May/Jun. 1989, p. 602)
- 11-15. **NSF/CBMS Conference on Wavelets**, University of Lowell, Lowell, MA. (Nov. 1989, p. 1251)
- 11-15. **IMACS First International Conference on Computational Physics**, Boulder, CO. (Jan. 1990, p. 57)
- *11-15. **The Mathematics of Computer Graphics**, Salisbury State Univ., Salisbury, MD.
- PURPOSE: To give college teachers a working knowledge of computer graphics.
LECTURER: J.W. Weiss.
INFORMATION: B.A. Fusaro, Dept. of Math. Sciences, Salisbury State University, Salisbury, MD 21801; 301-543-6470 or 6471.
- *11-15. **Undergraduate Faculty Enhancement "Workshop on Computational Number Theory"**, Univ. of Wisconsin-Whitewater, WI.

LECTURER: Carl Pomerance.
INFORMATION: R.M. Najjar, College of Letters and Sciences, Univ. of Wisconsin-Whitewater, Whitewater, WI 53190; 414-472-1620.

- 12-15. **Ninth International Conference on Analysis and Optimization of Systems**, Antibes, France. (Jan. 1990, p. 57)
- 12-15. **Workshop on Spectral and Scattering Theory of Partial Differential Operators**, Institute of Mathematics, He-

- brew Univ., Jerusalem, Israel. (Feb. 1990, p. 220)
- 13-15. **Seventh Annual Quality and Productivity Research Conference**, Madison, WI. (Mar. 1989, p. 315)
- 13-16. **Function Estimation and Statistical Applications**, Cornell University, Ithaca, NY. (Feb. 1990, p. 221)
- 13-22. **Free Boundary Problems: Theory and Applications**, Centre de Recherches Mathématiques, Université de Montréal, Canada. (Jul./Aug. 1989, p. 767)
- 14-16. **Sixth Summer Conference on General Topology and Applications**, Long Island Univ. (C.W. Post Campus), Brookville, NY. (Feb. 1990, p. 221)
- 14-16. **Fifth Southeast Asian Conference on Mathematical Education (SEACME 5)**, Gadong, Brunei Darussalam. (Nov. 1989, p. 1251)
- *14-16. **Function Estimation and Statistical Applications**, Cornell Univ., Ithaca, NY.

PURPOSE: This workshop will focus on using data to estimate unknown functions.

ORGANIZERS: D. Ruppert, Cornell Univ. and J.S. Marron, Univ. of North Carolina, Chapel Hill.

INVITED SPEAKERS: N. Altman, R. Carroll, D. Cline, D. Cox, R. Eubank, P. Hall, I. Johnstone, R. Liu, J.S. Marron, D. Nychka, J. Rice, D. Scott, P. Speckman, M. Wells.

INFORMATION: For scientific contact, D. Ruppert, School of Operations Research and Industrial Engineering, Cornell Univ., 343A Upson Hall, Ithaca, NY 14853, 607-255-9131; email: davidr@orie.cornell.edu. Telephone: V. Styles, Mathematical Sciences Institute, Cornell Univ., 201 Caldwell Hall, Ithaca, NY 14853-2602; 607-255-7740.

- 15-20. **Global Differential Geometry and Global Analysis**, Berlin, Federal Republic of Germany. (Jan. 1990, p. 57)
- 17-23. **Partial Differential Equations, Complex Analysis**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

18-20. **Joint WNAR-IMS Regional Meeting**, Montana State University, Bozeman, MT. (Mar. 1989, p. 315)

18-21. **A Conference on Partial Differential Equations, in Honor of Shmuel Agmon**, Inst. of Math., Hebrew Univ.

- Jerusalem, Israel. (Feb. 1990, p. 221)
- 18-22. **Fourteenth Mathematical Sciences Lecture Series on Partially Ordered Sets**, Johns Hopkins University, Baltimore, Maryland. (Oct. 1989, p. 1096)
- 18-22. **Approximations Diophantiennes et Nombres Transcendants**, Marseille, France. (Jan. 1990, p. 57)
- 18-23. **The Fifth International Conference on Topology and its Applications**, Dubrovnik, Yugoslavia.

ORGANIZING COMMITTEE: I. Ivanšić (Chairman), D. Adnadević (Vice-chairman), M. Mršević (Secretary), S. Mardešić, J. Vrabec.

CONFERENCE TOPICS: General topology, geometric topology, algebraic topology, differential topology, applications.

INFORMATION: Secretary: M. Mršević, Društvo Matematičara SR Srbije, Knez Mihailova 35/IV, p.p. 791, 11001 Beograd, Yugoslavia.

- 18-26. **Recent Developments in H_∞ Control Theory**, Villa Olmo, Como. (Feb. 1990, p. 221)

- 18-29. **Radar/Sonar**, Minneapolis, MN. (Nov. 1989, p. 1251)

- 18-29. **AMS-SIAM Summer Seminar on Vortex Dynamics and Vortex Methods**, University of Washington, Seattle, WA.

INFORMATION: B. Verducci, AMS, P.O. Box 6248, Providence, RI 02940.

- 20-22. **Sixteenth International Workshop on Graph-Theoretic Concepts in Computer Science**, Berlin, Federal Republic of Germany. (Jan. 1990, p. 57)

- 20-23. **Second Symposium on Chaotic Dynamical Systems**, Conference Center "Woudschoten" (near Utrecht), The Netherlands.

PURPOSE: The purpose of the symposium is the following: 1). The lectures consist of introductions to some subjects as well as a sketching overview of actual research, i.e. lectures for a broad audience. These lectures will be given by some leading researchers in the field. 2). There must be a sufficient amount of time to discuss with the prominent researchers. This does not only hold for advanced scientists but also for Ph.D. students. 3). The participating Ph.D. students will get the opportunity to present a poster.

INVITED SPEAKERS: M. Misiurewicz, Warsaw Univ.; F. Takens, Univ. of Groningen; T. Tél, Eötvös Univ.; J.A. Yorke, Univ. of Maryland; L.S. Young, Univ. of Arizona.

INFORMATION: H.E. Nusse, Rijksuniversiteit Groningen, Faculteit der Economische Wetenschappen, WSN-gebouw, Postbus 800, NL-9700 AV Groningen, The Netherlands.

- 24-30. **Mathematische Probleme in der Nichtlinearen Elastizität**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

- 25-29. **International Symposium on Fuzzy Approach to Reasoning and Decision Making**, Bochyne, Czechoslovakia. (Oct. 1989, p. 1096)

- 25-29. **Logique et Informatique**, Marseille, France. (Feb. 1990, p. 221)

- 25-July 13. **SMS-NATO ASI: Shape Optimization and Free Boundaries**, Université de Montréal, Montréal, Canada. (Dec. 1989, p. 1437)

- 27-29. **ACM Conference on Lisp and Functional Programming**, Nice, France. (Jan. 1990, p. 58)

- 27-30. **Fourth International Congress on Algebraic Hyperstructures and Applications**, Xanthi, Greece. (Apr. 1989, p. 496)

July 1990

- July 1990. **AMS Summer Research Institute on Differential Geometry**, University of California, Los Angeles, CA.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

- 1-7. **Modulfunktionen In Mehreren Variablen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

- 1-15. **International Symposium on Algebraic Topology - Adams Memorial Symposium**, University of Manchester, England. (Sep. 1989, p. 918)

- 1-18. **Twentieth Summer Session on Probability Theory**, Saint-Flour (Cantal), France. (Mar. 1989, p. 315)

- 2-6. **Tenth Australian Statistical Conference/Second Pacific Statistical Congress**, Sydney, Australia. (Jul./Aug. 1989, p. 768)

- 2-6. **The Jónsson Symposium**, Laugarvatn, Iceland. (Sep. 1989, p. 918)

- 2-6. **Thirty-fourth Annual Meeting of the Australian Mathematical Society**, Townsville, Queensland, Australia. (Oct. 1989, p. 1097)

- 2-6. **Fifteenth International Biometric Conference**, Budapest, Hungary. (Jan. 1990, p. 58)

- 2-7. **Groupes Ordonnés et Groupes de Permutation**, Marseille, France. (Jan. 1990, p. 58)

- 2-10. **Continua with Microstructures**, Villa "La Querceta", Montecatini Terme. (Feb. 1990, p. 222)

- 2-31. **Time Series**, Minneapolis, MN. (Nov. 1989, p. 1252)

- 2-August 10. **Représentations des Groupes et des Algèbres de Lie**, Université de Montréal, Canada. (Feb. 1990, p. 222)

- 3-6. **Eleventh Dundee Conference on Ordinary and Partial Differential Equations**, Dundee, Scotland. (Sep. 1989, p. 918)

- 5-7. **Lattice Path Combinatorics and Applications**, McMaster University, Hamilton, Ontario, Canada. (Feb. 1990, p. 222)

- 6-7. **International Colloquium on Applications of Mathematics (on the occasion of the 80th birthday of Lothar Collatz)**, Hamburg, West Germany. (Feb. 1990, p. 222)

- 8-14. **Variationsrechnung**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

- 9-11. **"Universita'di Genova - The Ohio State University Joint Conference" on New Trends in Systems Theory**, Genoa, Italy. (Jul./Aug. 1989, p. 768)

- 9-14. **4ème Colloque International de Theorie des Graphes et de Combinatoire**, Marseille-Luminy, C.I.R.M., France. (Jan. 1990, p. 58)

- 9-20. **Geometry and Topology of Four-Manifolds**, McMaster University, Hamilton, Ontario, Canada. (May/Jun. 1989, p. 602)

- * 15-20. **SIAM Annual Meeting**, Chicago, IL.

ORGANIZER: A. Manitius, George Mason Univ.

INFORMATION: SIAM, Conference Coordinator, Dept. CC0190, 3600 University City Science Center, Philadelphia, PA 19104-2688; tel 215-382-9800; Fax 215-386-7999; email:

siam@wharton.upenn.edu.

15-21. **Stochastic Image Models and Algorithms**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

15-22. **1990 European Summer Meeting (Logic Colloquium '90)**, University of Helsinki, Finland. (Feb. 1990, p. 222)

15-23. **Colloquium in Honor of Roland Fraisse**, Centre International de Rencontres Mathématiques, Luminy, France. (May/Jun. 1989, p. 602)

16-20. **SIAM Annual Meeting**, Chicago, IL. (Nov. 1988, p. 1389)

16-20. **Symposium Fraisse**, Marseille, France. (Jan. 1990, p. 58)

* 16-20. **NSF-CBMS Regional Conference "The Polynomial Identities and Invariants of $n \times m$ Matrices"**, DePaul Univ., Chicago, IL.

INVITED SPEAKERS: E. Formanek (Featured Lecturer), S.A. Amitsur, A. Berele, L. LeBruyn, S. Montgomery, L. Small.

INFORMATION: J. Bergen, Dept. of Math., DePaul Univ., Chicago, IL 60614; tel 312-341-8248; email: matjmb@depaul.bitnet.

* 16-21. **Design and Analysis of Scientific Experiments**, Cambridge, MA.

INFORMATION: Director of the Summer Session, Room E19-356, MIT, Cambridge, MA 02139.

* 16-27. **Regional Institute in Dynamical Systems**, Boston Univ., Boston, MA.

PROGRAM: A two week intensive short course on the basic ideas in dynamics, aimed at graduate students and college faculty. Opportunities for interactions with ongoing high school teacher enhancement programs in dynamics. Support from NSF for travel and lodging for participants is anticipated.

CONFERENCE TOPICS: Chaos, complex dynamics, circle and annulus maps, computer experiments in dynamics, and teaching dynamics.

INVITED SPEAKERS: P. Blanchard, R.L. Devaney, D. Fried, G.R. Hall.

INFORMATION: Dynamics Institute, Mathematics Dept., 111 Cummington St., Boston Univ., Boston, MA 02215; email: dynamics-inst@math.bu.edu.

22-28. **Konvexgeometrie**, Oberwolfach,

Federal Republic of Germany. (Apr. 1989, p. 497)

23-27. **CADE 10 - Tenth International Conference on Automated Deduction**, West Germany. (Feb. 1990, p. 223)

23-28. **Fourth International Congress on Computational and Applied Mathematics**, Leuven, Belgium. (Jan. 1990, p. 58)

23-August 4. **Third Workshop on Stochastic Analysis**, Silivri, Istanbul-Turkey. (Feb. 1990, p. 223)

26-29. **International Conference on New Trends in Geometric Function Theory and Applications**, University of Madras, Madras, India. (Sep. 1989, p. 918)

29-August 4. **Mechanik Und Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

30-August 4. **The Fourth International Conference on Fibonacci Numbers and their Applications**, Wake Forest University, Winston Salem, NC. (Nov. 1989, p. 1252)

31-August 2. **Dynamics of Numerics and the Numerics of Dynamics**, Bristol, England. (Nov. 1989, p. 1252)

August 1990

* 2-3. **AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology, Neural Networks**, Vancouver, Canada.

INFORMATION: Betty Verducci, AMS, P.O. Box 6248, Providence, RI 02940.

5-9. **From Topology to Computation: Unity and Diversity in the Mathematical Sciences (in Honor of Professor Stephen Smale's 60th Birthday)**, Berkeley, CA. (Jan. 1990, p. 58)

5-11. **Mathematical Methods in Tomography**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

5-11. **International Conference on Approximation Theory**, Hungary. (Oct. 1989, p. 1097)

6-7. **AMS Short Course on Combinatorial Games**, Columbus, Ohio.

INFORMATION: M. Foulkes, AMS, P.O. Box 6248, Providence, RI 02940.

6-9. **1990 Joint Statistical Meetings**, Anaheim, CA. (Mar. 1988, p. 466)

6-10. **Singularities**, Honolulu, Hawaii. (Feb. 1990, p. 223)

8-11. **Joint Mathematics Meetings**, Ohio State University, Columbus, OH, (includ-

ing the summer meetings of the AWM, MAA and PME). This is the 75th Anniversary of the MAA.

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

* 8-11. **The Fifth KIT Mathematics Workshop**, Korea Institute of Technology, Taejeon, Korea.

PROGRAM: Algebra and topology. The program will consist of a series of lectures by invited speakers, and some one-hour talks.

CALL FOR PAPERS: Papers are solicited in all areas of algebra and topology. Small amounts of financial support will be available to a limited number of talkers.

INFORMATION: Y. Yong Oh, Director, Mathematics Research Center, Korea Institute of Technology, Taejeon 305-701, Korea; fax: (Korea) 42-861-5631

* 12-13. **Workshop on Using Technology to Enhance the Teaching and Learning of Calculus and Precalculus Mathematics**, The Ohio State Univ., Columbus, OH.

PROGRAM: Fourth annual summer workshop for college mathematics faculty on the use of graphing calculators and computers in college calculus and precalculus instruction. Immediate after the annual summer AMS/MAA meetings in Columbus, OH.

INFORMATION: F. Demana and J. Waits, 1990 Summer College Workshop, The Ohio State University, Math Dept., 231 W. 18th Ave., Columbus, OH 43210.

12-18. **Algebraische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

12-18. **Pre-Congress Topology Conference**, University of Hawaii, Honolulu, HI. (Feb. 1990, p. 223)

13-16. **Alaska Conference, Quo Vadis Graph Theory?**, University of Alaska, Fairbanks, AK. (Oct. 1989, p. 1097)

13-17. **Fifth International Conference on Hadronic Mechanics and Nonperturbative Interactions**, University of Northern Iowa, Cedar Falls, Iowa. (Jul./Aug. 1989, p. 768)

13-17. **Eleventh IFAC World Congress**, Tallin, USSR. (Sep. 1989, p. 918)

13-17. **Algebraic Geometry and Analytic Geometry**, Tokyo, Japan. (Sep. 1989, p. 1097)

16-19. **Current Topics in Operator Algebras**, Nara Ken-New Public Hall, Nara, Japan. (Feb. 1990, p. 224)

18-22. **The Second International Conference on Graph Theory**, Kanagawa, Japan. (Feb. 1990, p. 224)

19-20. **Inverse Problems in Engineering Sciences**, Osaka Institute of Technology, Osaka, Japan. (Feb. 1990, p. 224)

19-25. **Mathematische Methoden Des VLSI-Entwurfs Und Des Distributed Computings**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

20-24. **Second International joint Conference of the ISSAC-90 and the AAECC-8**, Nihon University, Tokyo, Japan. (Feb. 1990, p. 224)

20-25. **Fifth Conference on Numerical Methods**, Miskolc, Hungary. (Jan. 1990, p. 59)

21-29. **The International Congress of Mathematicians 1990**, Kyoto, Japan. (Nov. 1988, p. 1389)

23-September 1. **Twenty-eighth International Symposium on Functional Equations**, Graz-Mariatrost, Austria. (Dec. 1989, p. 1438)

26-September 1. **Komplexe Analysis**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

27-31. **Eleventh Prague Conference on Information Theory, Statistical Decision Functions and Random Processes**, Praha, Czechoslovakia. (Jan. 1990, p. 59)

28-30. **IMACS European Simulation Meeting on Problem Solving by Simulation**, Esztergom, Hungary. (Mar. 1989, p. 316)

28-31. **Operations Research 1990, International Conference Operations Research**, Vienna, Austria. (Jul./Aug. 1989, p. 768)

29-31. **International Colloquium on Words, Languages, and Combinatorics**, Kyoto Sangyo University, Kyoto, Japan. (Feb. 1990, p. 224)

30-September 1. **International Symposium on the Semigroup Theory and its Related Fields**, Ritsumeikan University, Kyoto, Japan. (Feb. 1990, p. 224)

30-September 2. **International Symposium on Functional Differential Equations and Related Topics**, Kyoto Shigaku Kaikan (YOUANDI), Kyoto, Japan. (Feb. 1990, p. 224)

30-September 4. **International Conference on Potential Theory**, Nagoya, Japan. (May/Jun. 1989, p. 602)

30-September 4. **International Symposium on Computational Mathematics**, Matsuyama, Japan. (Feb. 1990, p. 224)

31-September 1. **Tokyo History of Mathematics Symposium 1990**, University of Tokyo, Tokyo, Japan. (Feb. 1990, p. 224)

31-September 2. **Conference on Representation Theories of Lie Groups and Lie Algebras**, Lake-Kawaguchi, Yamanashi, Japan. (Feb. 1990, p. 224)

31-September 4. **International Symposium on Functional Analysis and Related Topics**, Sapporo, Japan. (Feb. 1990, p. 225)

31-September 4. **General Topology and Geometric Topology Symposium**, University of Tsukuba, Japan. (Feb. 1990, p. 225)

September 1990

September/October 1990. **IMACS-GAMM Conference on Computer Arithmetic, Scientific Computation and Mathematical Modelling**, Bulgaria. (Sep. 1989, p. 919)

IMACS Symposium on Modelling and Simulation of Electrical Machines, ENSEM - Nancy, France. (May/Jun. 1989, p. 602)

2-7. **Twelfth International Conference on Nonlinear Oscillations**, Cracow, Poland. (Sep. 1989, p. 919)

2-7. **International Conference on Integral Equations and Boundary Value Problems**, Yantai University, Shandong, People's Republic of China. (Nov. 1989, p. 1253)

2-8. **Topologie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

3-6. **Fourth Asian Logic Conference**, Tokyo, Japan. (Mar. 1989, p. 316)

3-7. **IMACS Symposium on Intelligent Models in Systems Simulation**, Brussels, Belgium. (Mar. 1989, p. 316)

3-7. **Représentation des Groupes et Analyse Complexe**, Marseille, France. (Jul./Aug. 1989, p. 768)

3-7. **International Conference on Dynamical Systems and Related Topics**, Nagoya University, Nagoya, Japan. (Feb. 1990, p. 225)

* 3-8. **Physical Interpretations of Relativity Theory**, Imperial College, London, England.

PURPOSE: The conference will review the development, status and potential

13-17. **1990 International Conference on Parallel Processing**, Pennsylvania State University, University Park, PA. (Dec. 1989, p. 1438)

13-17. **NSF/CBMS Conference on Random Number Generation and Quasi-Monte Carlo Methods**, Univ. of Alaska, Fairbanks, AK.

PROGRAM: H. Niederreiter will give ten lectures emphasizing recent research in the interrelated areas of: quasirandom points and applications to numerical analysis; pseudorandom numbers and applications to Monte Carlo methods; linear complexity for pseudorandom sequences of bits and applications to cryptography. There will also be a few additional lectures by other participants.

INFORMATION: J.P. Lambert, Dept. of Mathematical Sciences, Univ. of Alaska, Fairbanks, AK 99775-1110; email: ffjpl@alaska.bitnet.

13-18. **Institute of Mathematical Statistics Fifty-third Annual Meeting (jointly with the Second World Congress of the Bernoulli Society)**, Uppsala, Sweden. (Sep. 1989, p. 919)

13-18. **Tsukuba International Conference on Representations of Algebras and Related Topics**, University of Tsukuba, Japan. (Nov. 1989, p. 1253)

14-18. **The Asian Mathematical Conference 1990**, Hong Kong, China. (Sep. 1989, p. 919)

14-18. **Harmonic Analysis, Sendai 1990**, Tohoku University, Sendai, Japan. (Feb. 1990, p. 223)

14-18. **Zeta Functions in Geometry**, Tokyo Institute of Technology, Tokyo, Japan. (Feb. 1990, p. 223)

15-19. **International Conference on Knot Theory and Related Topics**, International House, Osaka, Japan. (Apr. 1989, p. 497)

15-19. **International Conference on Commutative Algebra and Combinatorics**, Nagoya University, Nagoya, Japan. (Feb. 1990, p. 224)

15-20. **Conference on Gaussian Random Fields (The Third Nagoya Lévy Seminar)**, Nagoya University, Nagoya, Japan. (Nov. 1989, p. 1253)

16-18. **SIGAL International Symposium on Algorithms**, Tokyo, Japan. (Oct. 1989, p. 1097)

of the various physical interpretations of the Relativistic Formal Structure.

INFORMATION: Conference Coordinator, M.C. Duffy, School of Mech. and Manufacturing Engineering, Sunderland Polytechnic, Chester Rd., Sunderland SR1 3SD; tel (091) 5152856.

8-12. **Neuronet-90: IMACS International Symposium on Neural Nets and Neural Computers**, Prague, Czechoslovakia. (Please note change from May/Jun. 1989, p. 602)

9-15. **Surgery and L-Theory**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 10-12. **Second International Workshop on Advances in Robot Kinematics**, Linz, Austria. (Please note change in location from Jan. 1990, p. 59)

10-14. **Mathematiker-Kongress**, Dresden, German Democratic Republic. (Jul./Aug. 1989, p. 769)

10-14. **Greco Calcul Formel**, Marseille, France. (Jan. 1990, p. 60)

* 10-14. **Real Analysis and Measure Theory**, Capri, Italy.

SCIENTIFIC COMMITTEE: L. Albano, Univ. di Bari; V. Aversa, Univ. Federico II di Napoli; L. Barone, Univ. di Lecce; B. Bongiorno, Univ. di Palermo; M. Boni, Univ. di Modena; P. de Lucia, Univ. Federico II di Napoli; E. De Pascale, Univ. della Calabria; N.O. Berruti, Univ. di Pavia; M. Puglisi, Univ. di Bari; G. Santagati, Univ. di Catania; C. Vinti, Univ. di Perugia; A. Volčič, Univ. di Trieste; H. Weber, Univ. della Basilicata; C. Zanco, Univ. di Milano.

ORGANIZING COMMITTEE: Univ. Federico II di Napoli: P. de Lucia, V. Aversa, A. Basile, E. Guariglia.

INFORMATION: Dipartimento di Matematica e Applicazioni, Renato Caccioppoli dell'Università di Napoli, via Mezzocannone 8, 80134 Napoli, Italy.

10-October 5. **School on Qualitative Aspects and Applications of Nonlinear Evolution Equations**, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 602)

16-22. **Risikotheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

17-21. **Atelier International de Theorie des Ensembles**, Marseille, France. (Jan.

1990, p. 60)

17-22. **DMV-Jahrestagung 1990**, Bremen, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

23-29. **Random Graphs and Combinatorial Structures**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

24-28. **International Symposium on Mathematical Theories**, San Sebastián, Spain. (Jan. 1990, p. 60)

24-28. **Structure Galoisienne Arithmetique**, Marseille, France. (Jan. 1990, p. 60)

24-28. **IMACS-GAMM International Symposium on Computer Arithmetic, Scientific Computation and Mathematical Modelling - SCAN 1990**, Albena (near Varna), Bulgaria. (Feb. 1990, p. 225)

24-29. **Mathematical Modelling of Industrial Processes**, Tecnopolis, Bari. (Feb. 1990, p. 225)

30-October 6. **Diophantische Approximationen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

October 1990

1-5. **Organisations et Theorie des Jeux**, Marseille, France. (Jan. 1990, p. 60)

* 1-5. **Third Joint Europe/U.S. Short Course in Hypersonics**, RWTH Aachen Univ. of Technology, Federal Republic of Germany.

PROGRAM: Since hypersonic flight requires highly integrated systems the short course not only aims to give in depth analysis of hypersonic research and technology but also tries to broaden the views of attendees to give the ability to understand the complex problem of hypersonic flight. The course should interest post-graduate students, designers and researchers.

ORGANIZING COMMITTEE: J. Ballmann, Univ. of Aachen, FRG; R. Bec, CNES, France; J.J. Bertin, SANDIA National Labs.; M. Borsi, AIT-GAD, Italy; K.-H. Brakhage, Univ. of Aachen, FRG; A. Dervieux, INRIA, France; C. Dujarric, ESA, France; R. Glowinski, Univ. of Houston; W. Goodrich, AGARD/NASA; R. Graves, NASA; H. Grönig, Univ. of Aachen, FRG; E.H. Hirschel, MBB/GAMM, FRG; B. Holmes, NASA; R. Jeltsch, Univ. of Aachen, FRG; G. Koppenwallner, DLR Göttingen, FRG; W. Kordulla, DLR Göttingen, FRG; E. Krause,

Univ. of Aachen, FRG; P. Le Tallec, Univ. of Paris Dauphine, France; B. Monnerie, ONERA and AAE, France; R. Pellat, CNES, France; J. Periaux, Dassault Industries, France; M. Smith, U.S. Air Force Academy; J. Stollery, Cranfield Institute of Technology, UK; J. Wendt, VKI, Belgium.

CONFERENCE TOPICS: Physical environments, configuration requirements, propulsion systems including airbreathing systems, experimental methods for external and internal flow, theoretical and numerical methods.

INVITED SPEAKERS: J.J. Bertin, SANDIA Nat'l. Labs.; F.S. Billig, Johns Hopkins Univ.; R. Brun, Univ. de Provence, France; J. Cousteix, ONERA-CERT, France; M. Delery, ONERA/OA, France; J.-A. Desideri, INRIA, France; D. Hänel, RWTH Aachen, FRG; E.H. Hirschel, MBB-München, FRG; H. Hornung, California Inst. of Tech.; G. Koppenwallner, DLR, FRG; R.G. Lacau, Aérospatiale France; C.P. Li, NASA-JSC; M. Mallet, Dassault Industries, France; J.G. Marvin, NASA-ARC; C.G. Miller, III, NASA-LRC; R.D. Neumann, Wright-Patterson Labs; M. Pandolfi, Politecnico di Torino, Italy; P. Perrier, Dassault Industries, France; C.D. Scott, NASA-JSC; J.L. Steger, NASA-ARC; K.F. Stetson, Wright-Patterson Labs; J.L. Stollery, Cranfield Inst. of Tech. UK.

INFORMATION: Conference Office, K. H. Brakhage, Institut für Geometrie und Praktische Mathematik, RWTH Aachen, D-5100 Aachen, Fed. Rep. Germany; tel 49-241-80 3951; email Earn/Bitnet: ez010pm@dacth11.

5-6. **Math-History Conference**, La Crosse, WI. (Jan. 1990, p. 60)

* 5-7. **Workshop on Partial Differential Equations**, Cornell Univ., Ithaca, NY.

PROGRAM: The workshop is held in honor of Lawrence E. Payne, 25 years as a professor in Cornell University's Dept. of Math. It will focus on several topics within the general area of partial differential equations: non well-posed problems, isoperimetric inequalities, and time blowup.

INVITED SPEAKERS: C. Bandle, Univ. of Basil; J. Bell, Lawrence Livermore Labs.; J. Cannon, Lamar Univ.

Carasso, National Institute of Standards and Technology; K. Gustafson, Univ. of Colorado; C. Horgan, Univ. of Virginia; R. Knops, Harriot Watt Univ.; H. Levine, Univ. of Iowa; G. Philippin, Laval Univ., Quebec; M. Protter, Berkeley; D. Sather, Univ. of Colorado; B. Straughan, Univ. of Glasgow; H. Weinberger, Stanford Univ.

INFORMATION: A. Schatz, Dept. of Math., Cornell Univ., 303 White Hall, Ithaca, NY 14853; 607-255-2318; schatz@mssun7.msi.cornell.edu.

7-13. Arbeitsgemeinschaft Mit Aktuellem Thema, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

8-12. Congres Franco-Sovietique de Programmation Mathematique, Marseille, France. (Jan. 1990, p. 60)

14-20. Geometrie, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

15-19. Modeles pour L'Analyse des Donnees Multidimensionnelles, Marseille, France. (Jan. 1990, p. 60)

15-19. Tercer Congreso Nacional de Matematicas, San José, Costa Rica. (Feb. 1990, p. 225)

21-22. Eastern Section, University of Massachusetts at Amherst, Amherst, MA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

21-27. Mathematische Methoden In Der Robotik, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

21-27. Arithmetik der Körper, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

21-27. International Functional Analysis Meeting on the Occasion of the Sixtieth Birthday of Professor M. Valdivia, Peñíscola, Spain. (Oct. 1989, p. 1098)

22-25. Fifth Jerusalem Conference on Information Technology (JCIT-5), Jerusalem, Israel. (Jan. 1990, p. 60)

26-27. Statistical Mechanics at the 45th Parallel: Fourth Annual Meeting, Université de Montréal, Canada. (Feb. 1990, p. 226)

28-November 3. Mathematical Economics, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

29-November 2. Trieste Conference on Integrable Systems, Trieste, Italy. (Jan.

1990, p. 61)

29-November 2. Algorithmes Paralleles et Architectures Nouvelles, Marseille, France. (Jan. 1990, p. 61)

* 29-November 2. The International Conference "D-Modules and Microlocal Geometry", Lisbon, Portugal.

PROGRAM: The conference is devoted to the study of systems of linear partial differential equations, analytic singularities, microlocal geometry, and related topics.

SCIENTIFIC COMMITTEE: T.M. Fernandes (CMAF and Univ. of Lisbon), M. Kashiwara (RIMS, Univ. of Kyoto), P. Schapira (Univ. of Paris-Nord).

INVITED SPEAKERS: E. Andronikof (Univ. Paris-Nord, France), D. Barlet (Univ. Nancy, France), E. Björk (Univ. Stockholm, Sweden), J.M. Bony (Ecole Polytechnique, Paris, France), F. Castro (Univ. Sevilha, Spain), D'Agnolo (Univ. Paris-Nord, France), L. Hörmander (Univ. Lund, Sweden), Y. St. Laurent (CNRS, Univ. Grenoble, France), G. Lebeau (Univ. Orsay, France), F. Loeser (Univ. Paris VI, France), B. Malgrange (Univ. Grenoble, France), L. Narvaez (Univ. Sevilha, Spain), O. Neto (Univ. Lisboa, Portugal), T. Oshima (Univ. Tokyo, Japan), R. Rodrigues (Univ. Nova, Portugal), C. Sabbah (CNRS, École Polytechnique, Paris, France), M. Saito (Univ. Kyoto, Japan), J.P. Schneiders (Univ. Liège, Belgium), J. Sjöstrand (Univ. Orsay, France), D. Struppa (Univ. George Mason, USA), Trépau (Univ. Paris VI, France), Van Doorn (Univ. Katholieke, Nijmegen, The Netherlands), Van den Essen (Univ. Katholieke, Nijmegen, The Netherlands), M. Vergne (CNRS, École Normale Supérieure, France), J. Zampieri (Univ. Padova, Italy).

INFORMATION: International Conference "D-modules and microlocal geometry", T. M. Fernandes, CMAF, Complexo II, Av. Prof. Gama Pinto, 2, 1699 Lisboa Codex, Portugal; telefax (351 1) 765622; email bitnet: tmf@ptfml; tel 773338/773325.

29-November 16. Workshop on Mathematical Ecology, Trieste, Italy. (Jan. 1990, p. 61)

31-November 3. Latinamerican Seminar on Applications of Mathematics and

Computer Science to Biology, La Habana, Cuba. (Feb. 1990, p. 226)

November 1990

2-3. Central Section Meeting of the AMS, University of North Texas, Denton, TX.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

4-10. Wahrscheinlichkeitsmaße auf Gruppen, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

5-7. Second SIAM Conference on Linear Algebra in Signals, Systems & Controls, San Francisco, CA. (Sep. 1989, p. 920)

* 9-11. Third Annual Conference on Technology in Collegiate Mathematics, The Ohio State Univ., Columbus, OH.

PROGRAM: Conference runs from Friday morning, 11/9/90 through Sunday afternoon, 11/11/90. Advanced registration is advised.

CALL FOR PAPERS: To give a short talk, please contact the organizers and send a one page abstract before September 1, 1990.

INFORMATION: F. Demana and B. Waits, 1990 Technology Conference, The Ohio State Univ., Math. Dept., 231 W. 18th Ave., Columbus, OH 43210.

12-16. Supercomputing '90, New York, NY. (Sep. 1989, p. 920)

12-16. Workshop on Representations of Reductive Groups over Finite Fields, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

18-24. Komplexitätstheorie, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. Stochastische Approximation Und Optimierungsprobleme In Der Statistik, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. Lineare Modelle und Multivariate Statistische Verfahren, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

December 1990

2-8. Multigrid Methods, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

3-5. **First International Symposium on Uncertainty and Analysis: Fuzzy Reasoning, Probabilistic Methods and Risk Management**, College Park, Maryland. (Oct. 1989, p. 1098)

3-7. **Sixteenth Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, Palmerston North, New Zealand. (Feb. 1990, p. 226)

3-7. **SINO-JAPANESE Joint Seminar on Nonlinear PDEs with Emphasis on Reaction-Diffusion Aspects.**, Taipei, Taiwan. (Jan. 1990, p. 61)

3-7. **Workshop on General Group Representation Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

9-15. **Allgemeine Ungleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

16-22. **Mathematische Logik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-January 1. **Lineare Modelle Und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* **Spring 1991. IMACS International Symposium on Iterative Methods in Linear Algebra**, Brussels Free Univ., Brussels, Belgium.

INFORMATION: R. Beauwens, Fac. des Sc. Appl., C.P. 165, Univ. Libre de Bruxelles, Ave. F.D. Roosevelt, 50, B-1050 Brussels-BELGIUM; email: r01201@bbrbfu01.bitnet or P. de Groen, Dept. of Math. and Comp. Sci., Vrije Univ. Brussel, Pleinlaan, 2, B-1050 Brussels-BELGIUM; email: z00301@bbrbfu01.bitnet.

January 1991

7-10. **Sixth Caribbean Conference in Combinatorics and Computing**, University of the West Indies, St. Augustine, Trinidad. (Jan. 1990, p. 61)

16-19. **Joint Mathematics Meetings**, San Francisco, CA. (including the annual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940

February 1991

25-March 1. **IEEE Computer Society COMPCON Spring '91**, San Francisco, CA. (Jan. 1990, p. 62)

March 1991

* 21-23. **Sixth S.E.A. Meeting, Southeastern Approximation Theorists Annual Meeting**, Memphis State Univ., Memphis, TN.

INFORMATION: G. Anastassiou, Dept. of Math. Sciences, Memphis State Univ., Memphis, TN 38152.

* 22-23. **Southeastern Section, University of South Florida**, Tampa, FL.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

* 22-24. **Fifth SIAM Conference on Parallel Processing for Scientific Computing**, Houston, TX.

ORGANIZER: D. Sorensen, Rice Univ. INFORMATION: SIAM, Conference Coordinator, Dept. CC0190, 3600 University City Science Center, Philadelphia, PA 19104-2688; tel 215-382-9800; Fax 215-386-7999; email: siam@wharton.upenn.edu.

May 1991

* **May/June 1991. IMACS Workshop on Decision Support Systems and Qualitative Reasoning**, Toulouse, France.

INFORMATION: L. Trave-Massuyes, Laboratoire d'Automatique et d'Analyse des Systemes (LAAS), 7, Avenue du Colonel Roche, 31077 Toulouse Cedex, FRANCE; tel 61-33-52-00.

* 7-10. **IMACS Symposium on Modelling and Simulation of Control Systems**, Casablanca, Morocco.

CHAIRMAN: P. Borne (Lille, France), A. El Moudni (Casablanca), S. Tzafestas (Athens, Greece).

INFORMATION: A. EL Moudni, Laboratoire d'Automatique, Faculte des Sciences, BP 5366-Maarif, Casablanca, Morocco.

* 13-17. **Conference in Harmonic Analysis in Honor of E.M. Stein**, Princeton

University, Princeton, NJ.

PURPOSE: This conference will honor E.M. Stein on the occasion of his sixtieth birthday. It will focus on topics from harmonic analysis and related areas.

ORGANIZING COMMITTEE: C. Fefferman, R. Fefferman, S. Wainger.

INVITED SPEAKERS: W. Beckner, J. Bourgain, A.P. Calderón, M. Christ, R. Coifman, C. Fefferman, R. Fefferman, D. Jerison, P. Jones, J.L. Journé, C. Kenig, Y. Meyer, A. Nagel, D.H. Phong, S. Wainger, G. Weiss, T. Wolff.

INFORMATION: S. Kenney, Math. Dept. Princeton Univ., Princeton, NJ 08544

June 1991

* **June 1991. Third IMACS International Symposium on Computational Acoustics**, Harvard Univ., Cambridge, MA.

CHAIRMAN: D. Lee (Naval Underwater Systems Center), A. Robinson (Harvard Univ.), R. Vichnevetsky (Rutgers Univ.).

INFORMATION: D. Lee, Code 3122 Naval Underwater Systems Center, New London, CT 06320; tel 203-444-4438.

* 3-7. **1991 Annual Meeting of the Statistical Society of Canada**, Toronto, Ontario, Canada.

INFORMATION: J.-A. Chapman, Local Arrangements Chairperson, Hennepin Banting Breast Centre, Women's College Hospital, 5th Floor, Burton Hall, 60 Grosvenor Street, Toronto, Ontario M5S 1B2, Canada.

July 1991

* 15-17. **Fifth IFAC/IMACS Symposium on Computer Aided Design in Control Engineering Systems**, Swansea, UK.

INFORMATION: H.A. Barker, Dept. Electrical and Electronic Engineering, Univ. College of Swansea, Swansea, UK.

New AMS Publications

COMPUTATIONAL SOLUTION OF NONLINEAR SYSTEMS OF EQUATIONS Eugene L. Allgower and Kurt Georg, Editors (Lectures in Applied Mathematics, Volume 26)

Nonlinear equations arise in essentially every branch of modern science, engineering, and mathematics. However, in only a very few special cases is it possible to obtain useful solutions to nonlinear equations via analytical calculations. As a result, many scientists resort to computational methods.

This book contains the proceedings of the Joint AMS-SIAM Summer Seminar, "Computational Solution of Nonlinear Systems of Equations," held in July 1988 at Colorado State University. The aim of the book is to give a wide-ranging survey of essentially all of the methods which comprise currently active areas of research in the computational solution of systems of nonlinear equations. A number of "entry-level" survey papers were solicited, and a series of test problems has been collected in an appendix. Most of the articles are accessible to students who have had a course in numerical analysis.

Contents

Eugene L. Allgower and Kurt Georg, Numerically stable homotopy methods without an extra dimension; Giles Auchmuty, Duality algorithms for smooth unconstrained optimization; M. S. Berger, Antidotes for nonintegrability of nonlinear systems: Quasi-periodic motions; M. S. Berger, Bifurcation into folds of infinite dimension; Sharon L. Blich and James H. Curry, On the geometry of factorization algorithms; Klaus Böhmer, Defect corrections and mesh independence principle for operator equations and their discretizations; Klaus Böhmer and Mei Zhen, On a numerical Lyapunov-Schmidt method; A. Castelo, application to implicit ODEs; Thomas F. Coleman, On characterizations of superlinear convergence for constrained optimization; Jeanne Duvallet, Computation of solutions of two-point boundary value problems by a simplicial homotopy algorithm; Richard E. Ewing, Computational methods for nonlinear systems of partial differential equations arising in contaminant transport in porous media; R. Fletcher, Low storage methods for unconstrained optimization; A. Galantai, Block ABS methods for nonlinear systems of algebraic equations; Sylvie Gélinas and Rémi Vaillancourt, Application of Julia-Fatou iteration theory in dielectric spectroscopy; Kurt Georg, An introduction to PL diffusion equations and Newton-like methods; Ronald B. Guenther and John W. Lee, Convergence of the Newton-Raphson method for boundary value problems of ordinary differential equations; Patrick T. Parker and Jong-Shi Pang, A damped-Newton method for the linear

complementarity problem; Annegret Hoy and Hubert Schwetlick, Some superlinearly convergent methods for solving singular nonlinear equations; John K. Hunter, Numerical solutions of some nonlinear dispersive wave equations; H. Th. Jongen, Parametric optimization: Critical points and local minima; R. Baker Kearfott, Interval arithmetic techniques in the computational solution of nonlinear systems of equations: Introduction, examples, and comparisons; C. T. Kelley, Operator prolongation methods for nonlinear equations; Bruce N. Lundberg, Aubrey B. Poore, and Bing Yang, Smooth penalty functions and continuation methods for constrained optimization; S. McKay and J. W. Thomas, Application of the fast adaptive composite grid method to nonlinear partial differential equations; Raymond Mejia, Interactive program for continuation of solutions of large systems of nonlinear equations; Hans D. Mittelman, Nonlinear parametrized equations: New results for variational problems and inequalities; Alexander P. Morgan and Andrew J. Sommese, Generically nonsingular polynomial continuation; Alexander P. Morgan, Andrew J. Sommese, and Charles W. Wampler, Polynomial continuation for mechanism design problems; G. Russo, A Lagrangian method for collisional kinetic equations; Renate Schaaf and Klaus Schmitt, On the number of solutions of semilinear elliptic problems at resonance: Some numerical experiments; Jürgen Scheurle, Splitting of separatrices and chaos; Phillip H. Schmidt, PL methods for constructing a numerical implicit function; Hubert Schwetlick, Nonstandard scaling matrices in trust region methods; Michael W. Smiley, Numerical determination of breathers and forced oscillations of nonlinear wave equations; Min Sun, Numerical solutions of singular stochastic control problems in bounded intervals; W. C. Thacker, Large least-squares problems and the need for automating the generation of adjoint codes; Homer F. Walker, Newton-like methods for underdetermined systems; Y. Yomdin, Sard's theorem and its improved versions in numerical analysis; Tjalling J. Ypma, Finite difference approximation of sparse Jacobian matrices in Newton-like methods; Jorge J. Moré, A collection of nonlinear model problems.

1980 Mathematics Subject Classifications: 65H10, 65K05, 65K10, 65N10, 65N20, 65N25, 65N30, 90C30
ISBN 0-8218-1131-2, LC 90-27, ISSN 0075-8485
784 pages (hardcover), March 1990
Individual member \$129, List price \$215,
Institutional member \$172
To order, please specify LAM/26N

GEOMETRIC AND TOPOLOGICAL INVARIANTS FOR ELLIPTIC OPERATORS Jerome Kaminker, Editor (Contemporary Mathematics, Volume 105)

This volume contains the proceedings of the AMS-IMS-SIAM Summer Research Conference on "Geometric and

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Topological Invariants of Elliptic Operators," held in August 1988 at Bowdoin College. Some of the themes covered at the conference and appearing in the articles are: the use of more sophisticated asymptotic methods to obtain index theorems, the study of the η invariant and analytic torsion, and index theory on open manifolds and foliated manifolds. The current state of noncommutative differential geometry, as well as operator algebraic and K -theoretic methods, are also presented in several of the articles.

This book will be useful to researchers in index theory, operator algebras, foliations, and mathematical physics. Topologists and geometers are also likely to find useful the view the book provides of recent work in this area. In addition, because of the expository nature of several of the articles, it will be useful to graduate students interested in working in these areas.

Contents

Jeff Fox and Jonathan Bloch, *Asymptotic pseudodifferential operators and index theory*; **James Heitsch and Conner Lazarov**, *A Lefschetz theorem on open manifolds*; **Steven Hurder**, *Eta invariants and the odd index theorem for coverings*; **Conner Lazarov and James Heitsch**, *The Lefschetz fixed point theorem for foliated manifolds*; **Varghese Mathai and Alan L. Carey**, *L^2 -acyclicity and L^2 -torsion invariants*; **Hitoshi Moriyoshi**, *Secondary characteristic numbers and locally free S^1 actions*; **Werner Müller**, *L^2 -index theory, eta invariants and values of L -functions*; **Marc Rieffel**, *Non-commutative tori—A case study of non-commutative differentiable manifolds*; **Mel Rothenberg**, *Analytic and combinatorial torsion*; **Michael Taylor**, *Pseudodifferential operators and K -homology, II*; **Phillipe Tondeur and Jesús A. Alvarez López**, *The heat flow along the leaves of a Riemannian foliation*; **Shmuel Weinberger**, *Aspects of the Novikov conjecture*.

1980 *Mathematics Subject Classifications*: 46L80, 58G12
ISBN 0-8218-5112-8, LC 89-18660, ISSN 0271-4132
312 pages (softcover), March 1990
Individual member \$22, List price \$37,
Institutional member \$30
To order, please specify CONM/105N

PROCEEDINGS OF THE WORKSHOP ON LOGIC AND COMPUTATION

Wilfried Sieg, Editor

(Contemporary Mathematics, Volume 106)

This volume contains the proceedings of the Workshop on Logic and Computation, held in July 1987 at Carnegie-Mellon University. The focus of the workshop was the refined interaction between mathematics and computation theory, one of the most fascinating and potentially fruitful developments in logic. The importance of this interaction lies not only in the emergence of the computer as a powerful tool in mathematics research, but also in the various attempts to carry out significant parts of mathematics in computationally informative ways.

The proceedings pursue three complementary aims: to develop parts of mathematics under minimal set-theoretic assumptions; to provide formal frameworks suitable for computer implementation; and to extract, from formal proofs, mathematical and computational information. Aimed at logicians, mathematicians, and computer scientists, this

volume is rich in results and replete with mathematical, logical, and computational problems.

Contents

Michael Beeson, *Some theories conservative over intuitionistic arithmetic*; **Gianluigi Bellin**, *Ramsey interpreted: A parametric version of Ramsey's theorem*; **Douglas K. Brown**, *Notions of closed subsets of a complete separable metric space in weak subsystems of second order arithmetic*; **Wilfried Buchholz and Wilfried Sieg**, *A note on polynomial time computable arithmetic*; **Samuel R. Buss**, *Axiomatizations and conservation results for fragments of bounded arithmetic*; **Peter G. Clote**, *A smash-based hierarchy between PTIME and PSPACE*; **Solomon Feferman**, *Polymorphic typed lambda-calculus in a type-free axiomatic framework*; **Fernando Ferreira**, *Polynomial time computable arithmetic*; **Chris Goad**, *Metaprogramming in SIL*; **Kostas Hatzikiriakou and Stephen G. Simpson**, *WKL_0 and ordering of countable Abelian groups*; **Jeffrey L. Hirst**, *Marriage theorems and reverse mathematics*; **Daniel Leivant**, *Computationally based set existence principles*; **Ken McAloon**, *Hierarchy results for MIXED-TIME*; **A. Nerode and J. B. Remmel**, *Polynomial time equivalence types*; **Frank Pfenning**, *Program development through proof transformations*; **Rick Statman**, *Some models of Scott's theory LCF based on a notion of rate of convergence*; **Gaisi Takeuti**, *Sharply bounded arithmetic and the function a^{-1}* ; **Xiaokang Yu**, *Radon-Nikodym Theorem is equivalent to arithmetical comprehension*.

1980 *Mathematics Subject Classifications*: 03, 68
ISBN 0-8218-5110-1, LC 90-40, ISSN 0271-4132
312 pages (softcover), March 1990
Individual member \$22, List price \$37,
Institutional member \$30
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POINTS DE NASH DES ENSEMBLES SOUS-ANALYTIQUES

Wiesław Pawłucki

(Memoirs of the AMS, Number 425)

Directed at researchers in analytic geometry, this book focuses on the geometry of subanalytic sets. By definition, a subanalytic set on a real manifold is the image of a relatively compact semianalytic set under an analytic map; a semianalytic set is one which can be locally described by analytic equalities and inequalities. The author's main result is that, given a subanalytic set, the points at which the set is semianalytic forms a subanalytic set. In fact, the author also establishes the more general result of the subanalyticity of the set of Nash points of the original set. The proof involves such classical tools as triangulation, Puiseux parametrization, a Bertini theorem, as well as some less standard techniques.

Contents

Théorèmes principaux; Réduction au cas d'une hypersurface; Modifications des théorèmes principaux dans le cas d'une hypersurface; Ω -variétés spéciales et leurs éclatements; Théorème de Gabrielov; Achèvement de la démonstration.

1980 *Mathematics Subject Classifications*: 32B20; 32B30, 32C40, 32D20, 32C45
ISBN 0-8218-2430-9, LC 89-18471, ISSN 0065-9266
84 pages (softcover), March 1990
Individual member \$10, List price \$16,
Institutional member \$13
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A LATTICE OF CHAPTERS OF MATHEMATICS: INTERPRETATIONS BETWEEN THEOREMS

Jan Mycielski, Pavel Pudlák, and Alan S. Stern

(Memoirs of the AMS, Number 426)

Directed at mathematical logicians and philosophers, this book will provide readers with a theory of a relationship of interpretability between theories. The authors define chapters of mathematics to be equivalence classes of first order theories relative to interpretability of finite parts of one theory onto the other, and vice versa. This relation induces the structure of a distributive algebraic lattice in the set of those chapters. Some properties of theories, such as finite axiomatizability, completeness, and a new property called connectedness, correspond to natural algebraic properties of their chapters in this lattice. Those properties and the structure of the lattice are the main topics of the book. One of the useful aspects of the concept of a chapter is that it is closer to mathematical practice than the classical concept of first order theory.

Contents

Definitions and generalities; Elementary results about LC; The most significant theorems about LC; Cardinalities, chains and antichains; General results and the structure of LC; Results about special theories; Proof of Theorem 6.12.

1980 Mathematics Subject Classifications: 03B10; 03C07
ISBN 0-8218-2488-0, LC 89-18632, ISSN 0065-9266
76 pages (softcover), March 1990
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Institutional member \$13
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DERIVATIVES OF LINKS: MILNOR'S CONCORDANCE INVARIANTS AND MASSEY'S PRODUCTS

Tim D. Cochran

(Memoirs of the AMS, Number 427)

The equivalence relation of concordance on the set of links of circles in 3-space arises naturally in attempts to resolve singularities of immersed 2-spheres in a 4-dimensional manifold. In fact, certain unsolved link concordance problems are exactly the obstructions to successfully performing surgery on 4-manifolds as the higher-dimensional theory predicts.

Directed at low-dimensional topologists and knot theorists, this book investigates and clarifies higher-order cohomology operations (Massey products) on the complements of links. These concordance invariants are essentially equivalent to Milnor's $\bar{\mu}$ -invariants, which detect whether or not the longitudes of a link lie in the n^{th} term of the lower-central series of the fundamental group of the link complement. The

author defines geometric derivatives on the set of links and uses these to define higher-order linking numbers, which are seen to be "pieces" of Massey products and to have more geometric content.

His investigation leads to algorithmic realization results, calculational methods, and many new examples, including the first examples with trivial $\bar{\mu}$ -invariants which are not concordant to boundary links, as well as the first examples with trivial Alexander's module but non-trivial $\bar{\mu}$ -invariants. There are also new connections with geometric equivalence relations and with K. Orr's homotopy invariants.

Contents

Higher-order linking numbers; Derived links, derived linkings, and surface systems; Derived links and the lower central series; Computing G/G_n : The Geometric Rewrite; Calculating Milnor's $\bar{\mu}$ -invariants using the Geometric Rewrite; Formal Massey products and surface systems; Antiderivatives and the realization theorem; The effect of Bing-doubling and band-summing on the $\bar{\mu}$ -invariants; Relations to cobordism and Orr's invariants; Cobordism classification and realization; Questions and problems.

1980 Mathematics Subject Classifications: 57M25; 55S30, 57Q45, 20F14, 20F32
ISBN 0-8218-2489-9, LC 89-18593, ISSN 0065-9266
88 pages (softcover), March 1990
Individual member \$10, List price \$16,
Institutional member \$13
To order, please specify MEMO/427N

ELEMENTS OF THE THEORY OF ELLIPTIC FUNCTIONS

N. I. Akhiezer

(Translations of Mathematical Monographs, Volume 79)

This book contains a systematic presentation of the theory of elliptic functions and some of its applications. A translation from the Russian, this book is intended primarily for engineers who work with elliptic functions. It should be accessible to those with background in the elements of mathematical analysis and the theory of functions contained in approximately the first two years of mathematics and physics courses at the college level.

Contents

Chapter I. General theorems about elliptic functions; Chapter II. Modular functions; Chapter III. The Weierstrass functions; Chapter IV. Theta functions; Chapter V. The Jacobi functions; Chapter VI. Transformation of elliptic functions; Chapter VII. Additional facts about elliptic integrals; Chapter VIII. Some conformal mappings; Chapter IX. Extremal properties of fractions to which a transformation of elliptic functions reduces; Chapter X. Generalization of Tchebycheff polynomials; Chapter XI. Various supplements and applications.

1980 Mathematics Subject Classifications: 33-01, 33A25; 11F03, 14K20, 30C20, 14K07, 33A30, 32H25, 33A65, 65A05
ISBN 0-8218-4532-2, LC 89-18452, ISSN 0065-9282
248 pages (hardcover), March 1990
Individual member \$56, List price \$93,
Institutional member \$74
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THEORY AND APPLICATIONS OF DIFFERENTIABLE FUNCTIONS OF SEVERAL VARIABLES. XII

S. M. Nikol'skii, Editor

(Proceedings of the Steklov Institute, Volume 181)

This collection of papers is devoted to various problems in the theory of differentiable functions of several variables and their application to partial differential equations.

Among the topics addressed are: imbeddings and equivalent normings of various spaces of smooth functions of several variables defined on subsets of Euclidean spaces; constructive properties of various spaces of differentiable functions; convergence of multiple Fourier series; estimates of bilinear approximations of periodic functions and estimates of widths; variational problems on intervals and solutions of the hydrodynamic system for a viscous fluid; high precision algorithms for approximate conformal mappings of simply connected and doubly connected regions.

Contents

O. V. Besov, *Imbeddings of an anisotropic Sobolev space for a domain with the flexible horn condition*; **Ya. S. Bugrov**, *Imbedding theorems and convergence of multiple Fourier series*; **V. I. Burenkov**, *A theorem on iterated norms for Nikol'skii-Besov spaces, and its application*; **E. A. Volkov**, *High-precision practical results in conformal mappings of simply connected and doubly connected domains by the block method*; **M. L. Gol'dman**, *Imbedding with different metrics for spaces of Calderón type*; **G. A. Kalyabin**, *A characterization of spaces of Besov-Lizorkin-Triebel type with the help of generalized differences*; **V. I. Kolyada**, *On relations between moduli of continuity in different metrics*; **L. D. Kudryavtsev**, *Variational problems with free endpoints on bounded and unbounded intervals*; **G. G. Magaril-Ilyayev**, *Trigonometric widths of Sobolev classes of functions on \mathbb{R}^n* ; **V. N. Maslennikova and A. V. Glushko**, *Localization theorems of Tauberian type and the rate of decay of a solution of the system for the hydrodynamics of a viscous compressible fluid*; **N. V. Miroshin**, *On the maximal space of Vekua and spaces close to it*; **K. T. Mynbaev**, *The anisotropic Strichartz seminorm and capacities*; **S. M. Nikol'skii and P. I. Lizorkin**, *A new approach to the theory of the function spaces $B_{p,\theta}^r$ on the sphere*; **Yu. S. Nikol'skii**, *Integral estimates of differentiable functions in weighted anisotropic spaces on unbounded domains*; **M. O. Otelbaev**, *On coercive estimates of solutions of difference equations*; **V. N. Temlyakov**, *Estimates of best bilinear approximations of periodic functions*.

1980 *Mathematics Subject Classifications*: 30C20, 30C30, 30G20, 31B15, 39A12, 41A30, 41A46, 42B05, 45E35, 46E30, 46E35, 49C05, 76N10, 76U05; 26B05, 34B25, 34E99, 35A22, 35A35, 35A40, 35B40, 35B65, 35E99, 35J05, 42A10, 42A20, 45E05, 47B39, 65E05
ISBN 0-8218-3131-3, LC 68-1677, ISSN 0081-5438
304 pages (hardcover), March 1990
Individual member \$85, List price \$141,
Institutional member \$113
To order, please specify STEKLO/181N

The following publication originally appeared in the December Notices. It is being reprinted here with the correct title.

THE MEROMORPHIC CONTINUATION AND FUNCTIONAL EQUATIONS OF CUSPIDAL EISENSTEIN SERIES FOR MAXIMAL CUSPIDAL SUBGROUPS

Shek-Tung Wong

(Memoirs of the AMS, Number 423)

Eisenstein series are fundamental objects in the theory of automorphic forms, which has important applications in analytic number theory. There are a number of approaches for establishing the meromorphic continuation and functional equations of Eisenstein series, with the ideas of Selberg being especially influential.

This book presents a development, based on an idea of Selberg, of the analytic continuation of Eisenstein series by means of integral operators. Starting with a brief account of the role of Eisenstein series in the theory of automorphic forms, the author obtains the meromorphic continuation and functional equations of cuspidal Eisenstein series for the maximal cuspidal subgroups of a reductive real algebraic group with an arithmetic subgroup. The book's most significant contribution is the way it lays out the formalism to Selberg's approach in the context of an algebraic group and an arithmetic subgroup. The main line of argument requires only knowledge of elementary functional analysis and complex analysis.

Contents

The definition and basic properties of the Eisenstein series
The compact operators
Fredholm equations
Analytic continuation
Functional equations
The general case of several cusps

1980 *Mathematics Subject Classification*: 11
ISBN 0-8218-2486-4, LC 89-28399, ISSN 0065-9266
224 pages (softcover), January 1990
Individual member \$15, List price \$25,
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AMS Reports and Communications

Recent Appointments

Committee members' terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.

The following ad hoc committees have been discharged by the Council with thanks:

Committee to Review Procedures of the Council in Considering Issues, Committee on AMS Publications in Applied Mathematics, Committee on Election Scheduling, Committee on Electronic Exchange of Information (CEEI), Committee on Vending Software, Committee on Applied Mathematics, Committee on Fellowship Policy, Committee on NCTM Standards, Committee to Recommend Winners of Prizes for Automatic Theorem Proving.

The following individuals have been elected by the Council upon recommendation of the Editorial Boards Committee:

- M. Salah Baouendi (1992) as the Society's Representatives to the *American Journal of Mathematics*; the continuing member of the committee is David Gieseke (1991);

- Richard S. Palais (1992) to the *Bulletin Editorial Committee*; continuing members of the committee are Roger E. Howe (1990), and Murray H. Protter (1991), chair;

- H. Jerome Keisler (1992) to the *Colloquium Editorial Committee*; continuing members of the committee are Raoul H. Bott (1990), and Charles L. Fefferman (1991);

- Jon Barwise (1992), and Judy Green (1992) to the *Committee to*

Monitor Problems in Communication; continuing members of the committee are Nancy Gubman, consultant, William H. Jaco (ex officio), Arthur M. Jaffe (1991), Richard G. Larson (1990), Paul G. Nevai (1991), and Richard S. Palais (1990);

- Craig Huneke (1992), and Linda Preiss Rothschild (1992), to the *Contemporary Mathematics Editorial Committee*; continuing members of the committee are Richard W. Beals (1991), Sylvain E. Cappell (1991), Jonathan Goodman (1990), Jan Mycielski (1990), and Michael E. Taylor (1991);

- B. A. Taylor (1992) to the *Mathematical Reviews Editorial Committee*; he will also serve as chair. Continuing members of the committee are Leonard D. Berkovitz (1991), John L. Selfridge (1991), and Hans F. Weinberger (1990);

- Victor W. Guillemin (1992) and Marc A. Rieffel (1991), to the *Mathematical Surveys and Monographs Editorial Committee*; continuing members of the committee are David S. Kinderlehrer (1991) and M. Susan Montgomery (1990), chair;

- Walter Gautschi (1992) to the *Mathematics of Computation Editorial Committee*; continuing members of the committee are Donald Goldfarb (1990) and Andrew M. Odlyzko (1991);

- Lawrence F. Gray (1993), Jeff Kahn (1993), and Franklin D. Tall (1993) to the *Proceedings Editorial Committee*; continuing members of the committee are William W. Adams (1992), J. Marshall Ash (1992), Maurice Auslander (1992), Andreas Blass (1992), Frederick R. Cohen (1991), William J. Davis (1991), chair, Clifford I. Earle, Jr. (1992), Palle E.

T. Jorgensen (1992), Barbara Lee Keyfitz (1991), Kenneth R. Meyer (1991), Paul S. Muhly (1990), George C. Papanicolaou (1991), Louis J. Ratliff, Jr. (1991), Jonathan M. Rosenberg (1991), James E. West (1991), and Warren J. Wong (1991);

- Ronald L. Graham (1992) to the *Proceedings of Symposia in Applied Mathematics Editorial Committee*; continuing members of the committee are Alexandre Chorin (1992), chair, and Björn E. J. Dahlberg (1991);

- Avner D. Ash (1990), James W. Cannon (1993), Burgess Davis (1992), Judith D. Sally (1993), and Masamichi Takesaki (1993) to the *Transactions and Memoirs Editorial Committee*; David J. Saltman (1990) has been appointed chair. Continuing members of the committee are James E. Baumgartner (1991), Ralph L. Cohen (1990), Eugene B. Fabes (1992), Jerry L. Kazdan (1990), Roger D. Nussbaum (1991), Carl Pomerance (1991), and Audrey A. Terras (1991).

M. Susan Montgomery, then chair of the Board of Trustees, has appointed Frederick W. Gehring (ex officio) to the *Investment Committee*. Continuing members of the committee are Steve Armentrout (ex officio), and Franklin P. Peterson (ex officio), chair.

President William Browder has appointed the following individuals:

- Frederick J. Almgren, Jr., Jerry L. Bona, Hermann Flaschka, Barbara Keyfitz, David Mumford, Ivar Stakgold, and Hans F. Weinberger to an ad hoc *Committee on Applications of Mathematics*; Professor Bona will serve as chair;

- Louis Nirenberg (1991) to the *Committee on National Awards and*

Public Representation; continuing members of the committee are Michael Artin (ex officio), William Browder (ex officio), chair, and Robert Fossum (ex officio);

- Nicholas Katz (1993), and Francois Treves (1993) to the *Committee on Summer Institutes and Special Symposia*; Raghavan Narasimhan (1991) has been appointed chair. Continuing members of the committee are Barbara Lee Keyfitz (1992), Haynes R. Miller (1991), and Brian Parshall (1992). Terms expire on February 28;

- Sue Goodman (AMS, 1992) to the AMS-ASA-IMS-MAA-NCTM-SIAM *Committee on Women in the Mathematical Sciences*; other members of the committee are Marsha J. Berger (SIAM, 1992), Grace M. Burton (NCTM, 1990), Marjorie M. Enneking (NCTM, 1989), Nancy Flournoy (IMS, 1992), Susan Geller (AMS, 1991), chair, Mary Hesselgrave (MAA, 1991), Patricia A. Jacobs (IMS, 1990), Patricia Kenschaft (AWM), Jeanne W. Kerr (AMS, 1992), Betty K. Lichtenberg (NCTM, 1989), Edith Luchins (MAA, 1991), Joyce R. McLaughlin (SIAM, 1990), Anne Parkhurst (ASA), Magda Peligrad (IMS, 1991), Linda R. Petzold (SIAM, 1992), Frances Rosamond (MAA, 1992), M. Beth Ruskai (AMS, 1992), and Alice T. Schafer (MAA, 1991). NCTM members' terms expire on April 1 of the year given.

Presidents Lida K. Barrett (MAA) and William Browder (AMS) have appointed:

- Newman Fisher to the AMS-MAA *Arrangements Committee for the San Francisco Meeting* and as chair. Other members of the committee are Gerald Alexanderson (ex officio), William H. Jaco (ex officio), and Andy Roy Magid (ex officio).

- Leonard Gillman, Uta C. Merzbach, Everett Pitcher, and Sanford L. Segal to the AMS-MAA *Joint Archives Committee*.

Presidents Ivar Stakgold (SIAM) and William Browder (AMS) have

appointed Joel Spencer (1992) to the AMS-SIAM *Committee on Applied Mathematics*. Other members of the committee are James M. Hyman (1990), Lawrence A. Shepp (1991), Gilbert Strang (1991), and Robert F. Warming (1990).

Presidents Ivar Stakgold (SIAM), Stuart Kauffman (SMB), and William Browder (AMS) have appointed James W. Curran (1993), Marcus W. Feldman (1991), and Eric S. Lander (1993) to the AMS-SIAM-SMB *Committee on Mathematics in the Life Sciences*. Marc Mangel (1992) has been appointed chair. Continuing members of the committee are Jack D. Cowan (1991) and James Murray (1992).

The Council Meeting in Louisville

The Council met at 2:00 p.m. on 16 January 1990 in the Grand Ballroom North of the Hyatt Regency Louisville Hotel. President Browder presided.

The Council received the report of the Tellers for the 1989 Election. (See the following announcement in this section.) It received the report of the Teller for the Election to the Nominating Committee and for the Election to the Editorial Boards Committee. The new members of the Nominating Committee are:

Barbara Lee Keyfitz

Ray Kunze

Robert F. Williams

The new members of the Editorial Boards Committee are:

Linda Keen

Barry Simon

The Council received reports from many committees of the Society, most of them in written form.

It elected members to several editorial boards upon recommendation from its Editorial Boards Committee. These elections are reported in the "Recent Appointments" section. It agreed with the Board of Trustees to establish a new book series "Graduate Texts".

The Council continued to consider election matters. It agreed to send to the membership in the next (Fall 1990) election an amendment to the Bylaws that changes the term of office for the Vice-Presidents from two to three years. Another effect of this proposed amendment is that there will be only one Vice-President elected each year. It agreed to consider at its April 1990 meeting a proposed amendment that would limit to five the number of consecutive two-year terms a Treasurer or Associate Treasurer could serve. It asked that biographical information and statements of candidates appear in *Notices* at least two weeks before ballots are mailed. Regarding this, the Council has suggested that a "Nominator" be selected for each candidate for President(-Elect) to write an article for *Notices* about the candidate. It also raised to 200 words the "limit" on statements by candidates.

The Council once again considered the policy of publishing responses to book reviews in the *Bulletin*. A policy proposed by the Editorial Boards Committee was returned to the committee for reconsideration.

The Council gratefully accepted a contribution from Professor Joan Birman, the income from which will be used to fund a biennial award to honor the memory of Ruth Lytton Satter. The prize is to be for an outstanding contribution to research in mathematics during the past five years and is to be awarded to a woman mathematician.

The Council agreed to recommend a Bylaw amendment that would allow Emeritus Members to receive the *Bulletin* as a privilege of membership.

Finally, the Council passed resolutions of congratulations to the Mathematische Gesellschaft in Hamburg on the occasion of its 300th Anniversary and one to the Deutsche Mathematiker Vereinigung on the occasion of its 100th Anniversary.

The Council adjourned at 7:06 p.m.

Robert M. Fossum
Secretary
Urbana, Illinois

Election Results of 1989

The newly elected Vice-Presidents of the Society are Lenore Blum and Dennis P. Sullivan. The newly elected Members-at-Large of the Council are Sheldon Axler, Shing-Tung Yau, Joan S. Birman, Carl Pomerance, and Charles Herbert Clemens. The newly elected Trustee is John C. Polking.

All candidates in noncontested elections were elected to their respective offices.

The candidates elected to the Nominating Committee for 1990 are Barbara Lee Keyfitz, Ray A. Kunze, and Robert F. Williams.

The candidates elected to the Editorial Boards Committee for 1990 are Linda Keen and Barry Simon.

The composition of the Council for 1990 follows.

Council for 1990

President:
William Browder
President-Elect:
Michael Artin
Vice-Presidents:
Lenore Blum
Sun-Yung Alice Chang
Dennis P. Sullivan
Secretary:
Robert M. Fossum
Former Secretary:
Everett Pitcher
Associate Secretaries:
Joseph A. Cima
W. Wistar Comfort

Andy Roy Magid
Lance W. Small
Treasurer:
Franklin P. Peterson
Associate Treasurer:
Steve Armentrout

*One of these four is a voting member at each meeting.

Members-at-Large:
Jonathan L. Alperin
Sheldon Axler
Joan S. Birman
Fan R. K. Chung
Charles Herbert Clemens
Lawrence J. Corwin
Richard K. Guy
Rhonda J. Hughes
Robion C. Kirby
Irwin Kra
Albert Marden
Carl Pomerance
Michael C. Reed
Hugo Rossi
Harold M. Stark
William P. Thurston
Shing-Tung Yau

Representatives of Committees

Bulletin Editorial Committee
Murray H. Protter, Chair
Colloquium Editorial Committee
Raoul H. Bott, Chair
Committee to Monitor Problems in Communication
To be elected, Chair
Journal of the AMS
Michael Artin, Chair
Mathematical Reviews Editorial Committee
B. A. Taylor, Chair
Mathematical Surveys Editorial Committee
M. Susan Montgomery, Chair
Mathematics of Computation Editorial Committee
Walter Gautschi, Chair

Proceedings Editorial Committee
William J. Davis, Chair
Representative, Board of Editors of American Journal of Mathematics
M. Salah Baouendi
Science Policy Committee
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The Business Meeting in Louisville

The Business Meeting of 19 January 1990 began about 4:55 and followed immediately upon the award of the 1990 Cole Prize in Algebra and the 1990 Award for Distinguished Public Service. President Browder presided.

The Secretary reported that the Society had about 27,000 members at the end of 1989, that the financial picture was bright, and that the Council met and had acted upon various items (see second announcement in this section). The Secretary requested and received unanimous approval of a resolution of thanks for the the Local Arrangements Committee. The meeting adjourned at about 5:10 p.m.

After the business meeting, a panel discussed the role the Society should take in educational matters.

Robert M. Fossum
Secretary
Urbana, Illinois

Miscellaneous

Personal Items

Eliot W. Collins has been promoted to Information Management Specialist at AT&T in Piscataway, NJ. He is also a Visiting Lecturer in Mathematics at Rutgers University.

Paul R. Halmos, of Santa Clara University, has been awarded an honorary Doctor of Mathematics from the University of Waterloo and has been invited to give the Convocation address at that Institution's Spring Convocation for Mathematics.

K. Brooks Reid has been appointed Founding Faculty member and Professor of the new, twentieth campus of California State University, CSU San Marcos.

William H. Reid, Professor Emeritus of The University of Chicago, is now a professor in the Department of Mathematical Sciences at Indiana-Purdue University at Indianapolis.

Deaths

Arthur Bernhart, Retired Professor of the University of Oklahoma, died

on October 16, 1989, at the age of 81. He was a member of the Society for 43 years.

Morris H. DeGroot, of Carnegie-Mellon University, died on November 2, 1989, at the age of 58. He was a member of the Society for 31 years. (See the News and Announcements section of this issue of *Notices*.)

Hubert W. Ellis, Retired Professor of Queen's University, died on January 1, 1990, at the age of 71. He was a member of the Society for 43 years.

Herbert Gross, of the University of Zürich, died on October 29, 1989, at the age of 53. He was a member of the Society for 27 years.

Mark G. Krein, of Odessa, U.S.S.R., died on October 17, 1989, at the age of 82. He was a member of the Society for 17 years. (See the News and Announcements section of this issue of *Notices*.)

Edwin N. Lassettre, Professor Emeritus of Carnegie-Mellon University, died on January 16, 1990, at

the age of 78. He was a member of the Society for 2 years.

Dis Maly, of Troy, NY, died on July 31, 1989, at the age of 78. He was a member of the Society for 4 years.

Adrienne S. Rayl, of New Orleans, LA, died on November 27, 1989, at the age of 91. She was a member of the Society for 51 years.

D. Wexler, of the Faculté Universitaire Notre-Dame de la Paix, died on May 27, 1989, at the age of 51. He was a member of the Society for 12 years.

Frantisek Wolf, Professor Emeritus of the University of California at Berkeley, died on August 12, 1989, at the age of 84. He was a member of the Society for 48 years.

Visiting Mathematicians

Boris N. Apanasov (Novosibirsk, U.S.S.R.), Ohio State University, February 1990 to April 1990, in dimensional topology and geometry.



GROUP ACTIONS AND INVARIANT THEORY

A. Bialynicki-Birula, J. Carrell, P. Russell, and D. Snow, Editors
(Conference Proceedings, Canadian Mathematical Society, Volume 10)

This volume contains the proceedings of a conference, sponsored by the Canadian Mathematical Society, on Group Actions and Invariant Theory, held in August, 1988 in Montreal. The conference was the third in a series bringing together researchers from North America and Europe (particularly Poland). The papers collected here will provide an overview of the state of the art of research in this area. The conference was primarily concerned with the geometric side of invariant theory, including explorations of the linearization problem for reductive group actions on affine spaces (with a counterexample given recently by J. Schwarz), spherical and complete symmetric varieties, reductive quotients, automorphisms of affine varieties, and homogeneous vector bundles.

1980 Mathematics Subject Classifications: 14-02, 14L30, 1406, 20G05, 14D25
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Backlog of Mathematics Research Journals

Backlog. Information on the backlog of papers for research journals, primarily those published in North America, is reported to the Providence Office by those editorial boards which elect to participate. The figures are an estimate of the number of printed pages which have been accepted, but are in excess of the number required to maintain copy editing and printing schedules.

Observed Waiting Time. The quartiles give a measure of normal dispersion. They do not include extremes which may be misleading. Waiting times are measured in months from receipt of manuscript in final form to publication of the issue. When a paper is revised, the waiting time between an editor's receipt of the final

revision and its publication may be much shorter than is the case otherwise, so these figures are low to that extent.

The observations are made from the latest issue published, before the deadline for this issue of *Notices*, from journals that have actually been received by a subscriber in the Providence, Rhode Island, area; in some cases this may be two months later than publication abroad. If the waiting time as defined above is not given in the journal, if no new issue has been received since the last survey, or if the latest issue is for some reason obviously not typical, no times are given in this report and such cases are marked NA (not available or not applicable).

Journal	Number Issues per Year	Approximate Number Pages per Year	Backlog of Printed Pages		Editor's Estimated Time for Paper Submitted Currently to be Published (in Months)	Observed Waiting Time in Latest Published Issue (in Months)		
			12/31/89	6/30/89		Q ₁	M	Q ₃
Acta Inform.	8	800	0	0	5	5	6	7
Aequationes Math.	6	640	193	100	NR	7	9	13
Alg. Groups Geom.	4	500	0	0	6	8	9	17
Algorithmica	4	576	103	120	16	21	23	28
Amer. J. Math.	6	1200		0	12-18	13	14	15
Ann. of Math.	6	1200	500	700	9	18	18	19
Ann. Probab.	4	1650	500	300	12-18	14	15	16
Ann. Sci. École Norm. Sup.	4	650	0	47	15	9	10	11
Ann. Statist.	4	1750	650	225	18	12	13	15
Appl. Math. Letters	4	400	50	0	3		*	
Appl. Math. Optim.	6	672	0	180	11	10	11**	12
Arch. Hist. Exact Scis.	4	400	0	0	11	9	NA	12
Arch. Math. Logic	4	300	0	0	8	7	9	11
Arch. Rational Mech. Anal.	20	2000	0	0	10	10	12	13
Bull. Austral. Math. Soc.	6	1000	400	400	12		NA	
Canad. J. Math.	6	1152	200	0	8-10	9	14	14
Canad. Math. Bull.	4	512	512	614	18	14	17	19
Circuits Systems Signal Proc.	4	512	0	0	10	9	10	13
Comm. Algebra	12	3600	2123	1602	10	10	13	18
Comm. Math. Phys.	24	5184	0	0	8	8	9	11
Comm. Partial Diff. Equations	12	1600	NR	200	NR	4	4	10
Computing	24	2400	NR	1000	NR	12	12	13
Constr. Approx.	8	768	180	280	8	9	10	12
	4	448	0	100	13	12	14	14

Journal	Number Issues per Year	Approximate Number Pages per Year	Backlog of Printed Pages		Editor's Estimated Time for Paper Submitted Currently to be Published (in Months)	Observed Waiting Time in Latest Published Issue (in Months)	
			12/31/89	6/30/89		Q ₁	M
Discrete Comput. Geom.	6	600	350	375	14	28	32
Duke Math. J.	6	1500	100	150	9	5	8
Houston J. Math.	4	600	NR	600	NR	***	***
Illinois J. Math.	4	704	NR	897	NR	26	27†
IMA J. Appl. Math.	6	510	0	0	14	8	10
IMA J. Math. Appl. Med. Biol.	4	350	80	0	6		NA
IMA J. Math. Control Inform.	4	350-400	NR	NR	NR	8	12
IMA J. Numer. Anal.	4	600	100	100	8-16	9	11
Indiana Univ. Math. J.	4	1000	NR	80	NR	9	10
Inst. Hautes Études Sci. Publ. Math.	2	400	0	0	15	12	15
Internat. J. Math. Math. Sci.	4	832	145	100	NR	16	19
Invent. Math.	12	2688	0	0	8	7	8
Israel J. Math.	12	1500	600	350	8	8	10
J. Algorithms	4	600	NR	NR	NR	14	22
J. Amer. Math. Soc.	4	1000	0	0	0	6	7
J. Amer. Statist. Assoc.	4	1200	0	NA	9	7	8
J. Appl. Math. Simulation	4	80	200	180	5-6		NA
J. Assoc. Comput. Mach.	4	1000	NR	300	NR	9	11
J. Austral. Math. Soc. Ser. A	6	1100	500	600	18	19	21
J. Austral. Math. Soc. Ser. B	4	512	0	256	NR	10	12
J. Classification	2	300	NR	0	NR		NA
J. Complexity	4	500	150	NA	9-12		NA
J. Comput. System Sci.	6	1200	50	200	12-16		NA
J. Differential Geom.	6	1800	1600	1300	10-12	17	18
J. Integral Equations Appl.	4	600	0	0	8		*
J. Math. Biol.	6	720	0	0	7	6	6
J. Math. Phys.	12	3200	0	0	5	4	4**
J. Nigerian Math. Soc.	1	100	NR	NR	NR		NA
J. Operator Theory	4	800	100	0	15	17	19
J. Symbolic Logic	4	1344	0	100	15	13	15
Linear Algebra Appl.	16	4800	600	600	12	12	14**
Manuscripta Math.	16	1792	0	0	6	5	6
Math. Ann.	12	2304	0	0	12-13	8	10
Math. Comput. Modelling	16	1600	NR	500	NR	7	8**
Math. Comp.	4	1500	240	260	12	11	13
Math. Control Signals Sys.	4	400	NR	1000	NR		NA
Math. Oper. Res.	4	800	600	360	18	16	17
Math. Programming Ser. A	6	720	240	240	15	21	*
Math. Social Sci.	6	600	0	180	12		NA
Math. Systems Theory	4	256	0	0	9	6	13
Math. Z.	12	1824	0	0	13-14	12	16
Mem. Amer. Math. Soc.	6	2800	0	0	4	7	15
Michigan Math. J.	3	480	100	130	18	10	8
Monatsh. Math.	8	704	0	0	6	7	8
Numer. Funct. Anal. Optim.	10	1250	0	0	5	6	9
Numer. Math.	16	1664	0	0	5	8	17
Oper. Res.	6	1008	NR	420	NR	12	23
Pacific J. Math.	10††	2000††	NR	NR	14	14	9
Probab. Theor. Relat. Fields	12	1920	0	0	11	8	12
Proc. Amer. Math. Soc.	12	3432	0	572	10-12	11	13
Proc. London Math. Soc.	6	1250	250	NR	16-18	11	13
Quart. Appl. Math.	4	800	400	200	12		

Journal	Number Issues per Year	Approximate Number Pages per Year	Backlog of Printed Pages		Editor's Estimated Time for Paper Submitted Currently to be Published (in Months)	Observed Waiting Time in Latest Published Issue (in Months)		
			12/31/89	6/30/89		Q ₁	M	Q ₃
Quart. J. Math. Oxford Ser. (2)	4	512	128	96	12	17	21	23
Quart. J. Mech. Appl. Math.	4	625	0	0	13	11	12	14
Results Math.	4	768	0	0	8	4	7	13
Rocky Mountain J. Math.	4	1000†††	1700		32		***	
Semigroup Forum	6	768	0	200	9	11	11	12
SIAM J. Appl. Math.	6	1845	129	500	10**	12	12**	15
SIAM J. Comput.	6	1280	0	200	8**	10	11**	12
SIAM J. Control Optim.	6	1480	196	350	9**	9	10**	11
SIAM J. Discrete Math.	4	600	112	50	9	8	9**	10
SIAM J. Math. Anal.	6	1500	456	430	11**	10	11**	12
SIAM J. Matrix Anal. Appl.	4	600	338	150	11**	9	10**	10
SIAM J. Numer. Anal.	6	1550	257	550	10**		NA	
SIAM J. Sci. Statist. Comput.	6	1200	447	400	13**	13	14**	15
SIAM Rev.	4	725	0	0	9**	5	6**	7
Topology Appl.	12*	1320	1430	500	13	16	17	18
Trans. Amer. Math. Soc.	12	5000	200	200	16	20	20	28

NR means no response received.

NA means not available or not applicable.

* Date of receipt or acceptance of manuscript not given.

** From date accepted.

*** This journal recently ended a moratorium on the acceptance of new papers; latest issue consists of pre-moratorium papers.

† Dates of revisions not indicated.

†† For 1990: 12 issues and 2400 pages per year.

††† Publication will increase by 60% by 1991.

UNIMODAL LOG-CONCAVE AND PÓLYA FREQUENCY SEQUENCES IN COMBINATORICS

Francesco Brenti

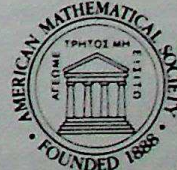
(Memoirs of the AMS, Number 413)

In recent years, considerable research has focused on unimodal or log-concave sequences that are of combinatorial interest. Although these two properties have simple definitions, proving that a sequence is unimodal or log-concave is often a difficult task requiring refined and sophisticated mathematical tools from such areas as representation theory, algebraic geometry, or classical analysis.

The main purpose of this book is to show the theory of total positivity can be very useful in studying this area. In the first part of the book, after discussing some combinatorial motivations, the author studies some of the fundamental linear transformations that preserve the log-concavity or Pólya frequency properties of a sequence. This part forms the theoretical core of the work and may be read independently from the rest. In fact, this rich and powerful theory can be

applied to any situation in which log-concavity and unimodality questions arise. The second part of the book is devoted to applications to several combinatorial situations, yielding many new results and solutions to some problems that had resisted attack with other techniques. Both parts of the book point to many conjectures, open problems, and directions for further study.

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- Jretai Yu
- University of Oregon*
Kuei-Fang Chang
Cynthia A Gibson
Catherine Ann Miner
Wendelle L Rawlinson
Karen Louise White
Nanping Yang
- University of Ottawa*
Youjian Fang
Thomas Patrick McLeister
Gilbert Remillard
- University of Pennsylvania*
Xiuxiong Chen
Liming Ge
David S Grigoryan
Wei Qing Gu
Mogens Lemvig Hansen
Lei Hong
Kjeld Knvosen Jensen
Megan M Kerr
Seon-In Kwon
Mehrddad Samadani
James Clark Satterthwaite
Mike Tam
Gerrit Wiegink
- University of Pittsburgh, Pittsburgh*
Rachel K Hayes
Hans E Johnston
Charles J Kicey
Xuming Lei
Barbara M Maskal
Joseph Edward Poullet
Thomas J Richards
Lei Tsui
Aiping Wang
Xiaolin Wang
Chong Xu
Lianying Xue
Yue Zhao
- University of Puerto Rico, Mayaguez*
Eric Aviles
Silvestre Colon
Nilsa Cruz
Rene Davila
Patricia Hernandez
Jorge Lopez
Jesus Novoa
Flor-Constanza Sanmiguel
Jose Villalobos
- University of Quebec, Chicoutimi*
Sylvain Boivin
- University of Rochester*
Jose A Gaggero
Jesus E Gonzalez
Yanjie Kang
Ran Levi
Changmei Liu
Dai Tamaki
Hezhou Tu
Yingzhong Wen
Kerri Lynne Workman

University of San Francisco
Tristan Needham

University of Southern California
Arif Mohamed Ansari
Lynn Beckett-Lemus
Maha Albert Chabhar
Leonard Y Cho
Aniruddha Datta
Chin-pang Alex Fung
Gary A Gilmore
Paul F Glezen
Cherie L Gragnano
Elke M Hennig
Joseph W Hogan
Marianne Huebner
Paul M Kulesa
Chen-Yao G Lai
Waidong Lee
Weishi Liu
Ho Ming Luk
Subhash R Malakar
Mark Nichols
Andreas P Petrou
Poornima Rajamani
Yegan Satik
Philipp H Stephanus
Chi Chung Tong
Aurelija Trgo
Susanne K Watter

University of Southern Mississippi
Stephanie Renee Blackwood
Joydeep Ghoshal
Ming Ma
Robin Mukherjee
Ni Zhou

University of Southwestern Louisiana
Liet Anh Do
Chunho Han
Lan Ke
Catherine Pui-Kan Kong
Saiming Lee

University of Texas at El Paso
Jinbao Chen
Roger A King
Chuck Littleton
Zheng Ma
Chengke Sheng

University of Texas-Pan American
Joseph E Chance

University of Toronto
Gary F Baumgartner
Habib E Chahin
Sebastian Esteban Ferrando
Martin Forest
Minh Dzung Ha
Christopher J Halonen
Niloofar Hodjati
Soheil Homayouni
Tai-Hing Dennis Hui
Andrew J Irwin
Isabella Joanna Laba
Stephen Peter Lee
Dennis Ray Lomas

Dimitrios Loukanidis
David M Neto
Giovanni Panti
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Steve G Sculac
Roger R Singh
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Kristina Ann Bogar
Elizabeth Michael Brown
Alberto Castro
Val A Cummings
John C Dallan
Ha Thi Minh Dang
Ashley Michelle DuLac
Stephen G Kurtz
Lorel M Preston
Robert William Stokes
Endre B Szabó
Yuanhua Tang
Craig C Tingey

University of Vermont
Nathan D Bokil
Theresa E Devlin
Yong Duan
Laurie A Hurley
Douglas W Mace
Angela B Martinek
Leo B Schillinger

University of Victoria
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Jacqueline Anderson Hall
Sharon L Laubach
Deirdre Longacher Smeltzer
Todd A Smith
Donald E Spickler Jr
James T Wilmet

University of Western Ontario
Xiaopeng Gao
Tim K L Liu
Jack C Singleton

University of Wisc, La Crosse
Patrick C Ward

University of Wisc, Milwaukee
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Yun Li
Rossen R Parashkevov
Linda K Prior
Zhongde Wang

University of the West Indies
Varalakshmi Duvvuri
Ansari Khayam Mohammed
Junior G Solan

Utah State University
Chris L Bendixen
Joan Leilani Dana
Xiaoli Hu
Keng Lee
Jianhua Shao
Lu Zhou

VPI & SU
Elizabeth A Bonawitz
David B Borisuk
Jiuyi Cheng
Raymond A Conner
Lisa K Cooley
Denise Lynette Davis
Guor-Rong C Duh
Dhananjary R Gokhale
Gitanjali S Gulve
Susan M Hagen
Heath D Hart
Wei Huang
Chun Wai Ip
Rajeev R Joshi
Addison B Jump
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Hong-Chul Kim
Xiao G Li
Rongsheng Liu
James K Lynch
Hamadi Marrekchi
Janice E Miller
Alfred Kenric Mulzet
Kevin A Newman
Eileen T Shugart
G Dennis Sparks
Matt L Stephens
Robert L Vanderheyden
Ivelina Julianova Velikova
Janet L Wade
Jennifer S Wilson
Denise Wolford
Scott A Yokim
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Vanderbilt University
Chao Cai
D Brian Conley
Robert N Gore
Lu Han
Sheri R Jordan
Walter Bruce Kessler
Stanley B Reed Jr

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Scott J Kromis
Nghia V Le
Lisa A Sigler

Washington & Lee University
Harry Todd Pearce

Washington State University
Michael D Brands
Richard Roy Drake
Juan Du
William A Kimball
Dongmei Liu
Dali Luo
Pete B McGill

Allen R Miedema
Nandita Rath
Carolyn M Scharmer
Kwang-sik Song

Washington University
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Jianwen Wang

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Neil H Alexander
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Zhibing Deng
Ishita Dutta Gupta
Hassan K Hamdan
Song Miao
John C Niss

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Michael J Bennett
Marjorie A Darrah
Leslie Ann Dumire
Timothy Jon Hempleman
James M Sconyers
Ling Zhang

Western Carolina University
Laura C Hannah
Mitchell Lane Helms
Robert Dewey Herring

Western Illinois University
Donald E Swanger

Western Kentucky University
Brian K Anderson

Western Washington University
John H Clifford
Maryann L Firpo
David Qun Li
Samuel J Lightwood
Christopher C McCormick
Elizabeth Jean Wood

Westminster College
Carolyn K Cuff

Yale University
Bertrand M Hochwald

Yeshiva University
Moshe Arye Milevsky

York University
Paul Betts

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Michel K Azzi
James M Brenneis
Jeffrey Walter Gill
Scott Alan Miller
Eunice E Santos
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SUGGESTED USES for classified advertising are positions available, books or lecture notes for sale, books being sought, exchange or rental of houses, and typing services.

THE 1990 RATE IS \$50.00 per inch on a single column (one-inch minimum), calculated from the top of the type; \$22 for each additional $\frac{1}{2}$ inch or fraction thereof. No discounts for multiple ads or the same ad in consecutive issues. For an additional \$10 charge, announcements can be placed anonymously. Correspondence will be forwarded.

Advertisements in the "Positions Available" classified section will be set with a minimum one-line headline, consisting of the institution name above body copy, unless additional headline copy is specified by the advertiser. Advertisements in other sections of the classified pages will be set according to the advertisement insertion. Headlines will be centered in boldface at no extra charge. Classified rates are calculated from top of type in headline to bottom of type in body copy, including lines and spaces within. Any fractional text will be charged at the next $\frac{1}{2}$ inch rate. Ads will appear in the language in which they are submitted.

Prepayment is required of individuals but not of institutions. There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified advertising.

DEADLINES are listed on the inside front cover or may be obtained from the AMS Advertising Department.

U. S. LAWS PROHIBIT discrimination in employment on the basis of color, age, sex, race, religion or national origin. "Positions Available" advertisements from institutions outside the U. S. cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to U. S. laws. Details and specific wording may be found near the Classified Advertisements in the February and July/August issues of the *Notices*.

SITUATIONS WANTED ADVERTISEMENTS from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the U.S. and Canada for further information.

SEND AD AND CHECK TO: Advertising Department, AMS, P.O. Box 6248, Providence, Rhode Island 02940. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 02904. Individuals are requested to pay in advance, institutions are not required to do so. AMS FAX 401-331-3842.

POSITIONS AVAILABLE

ALABAMA

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM DEPARTMENT OF MATHEMATICS

Applications are invited for one or more anticipated tenure or tenure-track positions. Preference will be given to strong candidates whose research interests are compatible with those of our current faculty; this includes numerical PDE/Scientific computation, mathematical physics, partial differential equations, nonlinear analysis, dynamical systems, including topological dynamics, and differential geometry. Faculty members have access to the Alabama Super Computer (using a Sun Station and a T-1 line to a Cray X-MP/24). Rank and salary will be subject to qualifications, but applicants for senior positions must have demonstrated excellence in research, while applicants for junior positions must exhibit the promise of excellence. Send as soon as possible a curriculum vita, selected reprints, and three letters of reference (candidates for senior positions may choose to submit a list of references instead) to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/Equal

Opportunity Employer.

CALIFORNIA

CHAFFEY COMMUNITY COLLEGE MATH INSTRUCTOR

The Physical Science Division invites applications for a full-time, tenure-track Math instructor to teach selected Mathematics courses ranging from Arithmetic to Differential Equations.

The ideal candidate will demonstrate a strong commitment to the needs of the diverse academic, socioeconomic, cultural, disability, and ethnic backgrounds of community college students.

Minimum qualifications are Master's degree in Mathematics OR Applied Mathematics; OR Bachelor's degree in either of the above AND Master's degree in Statistics, Physics, or Mathematics Education; OR Master's degree in Teaching Mathematics; OR current California Community College credential that permits full-time service as an instructor of Math; AND teaching experience.

In addition to contributions made in the classroom, this individual will perform professional tasks with an emphasis on student advisement, curriculum design and evaluation, program review, and other affairs of

the department and division. Salary range 26, 107.27-37,023.85.

Submit District application, including a detailed summary of educational preparation, experience, copies of transcripts, and placement file or three professional reference letters to:

Personnel Services
CHAFFEY COMMUNITY COLLEGE
5885 Haven Avenue
Rancho Cucamonga, CA 91701-3002
AA/EOE

STANFORD UNIVERSITY Department of Mathematics and Statistics

We invite applications for a tenure-track position in probability at the Assistant Professor level beginning Autumn Quarter 1990 to 1991. The position is a joint appointment in the Department of Mathematics and Statistics. Excellent research potential in probability and stochastic processes, strong interest in applications, and commitment to quality teaching are required. Outstanding candidates at higher ranks will also be considered. Please submit applications, curriculum vitae and letters from three professional references to: Yitzhak Katznelson, Chairman of Search Committee, Department of Mathematics, Stanford University, Stanford, CA 94305-2125, U.S.A.

Stanford University is an Equal Opportunity, Affirmative Action Employer, and welcomes applications from women and minorities.

UNIVERSITY OF CALIFORNIA AT BERKELEY BERKELEY, CA 94720 TEMPORARY POSTDOCTORAL POSITIONS DEPARTMENT OF MATHEMATICS

Several temporary positions beginning in Fall 1990 are anticipated for new and recent Ph.D.'s of any age, in the areas of algebraic analysis, applied mathematics, foundations or geometry and topology. The terms of these appointments may range from one to three years. Applicants for NSF or other postdoctoral fellowships are encouraged to apply for these positions; combined teaching/research appointments may be made up to three years. Mathematicians whose research interests are close to those of regular department members will be given preference. Send by April 1, 1990 a resume and reprints, preprints, and/or dissertation abstract. Ask three people to send letters of recommendation to Andrew J. Casson, Chair for Faculty Affairs, at the above address. (Applications received for our earlier January 15, 1990 deadline will automatically be

considered for this deadline will automatically be considered for this deadline also.) The University of California is an Equal Opportunity, Affirmative Action Employer.

**UNIVERSITY OF CALIFORNIA
IRVINE
DEPARTMENT OF MATHEMATICS
IRVINE, CA 92717**

The University of California at Irvine has made a significant commitment for the development of the mathematics department. A number of faculty appointments will be made over the next few years. These include:

1. At least five full time positions at any of the tenured professorial levels. The Department is particularly interested in areas of Algebra, Analysis, Applied Mathematics, Geometry, Mathematical Physics, Numerical Analysis-Scientific Computing, Probability, and Topology. Selection will be based on research experience and teaching ability.

2. At least one full time tenure track Assistant Professor position. Candidates must have a Ph.D. and a research record either in Mathematical Physics or Differential Geometry.

Applications must include curriculum vitae, bibliography and three letters of reference. The COMMITTEE ON STAFFING will solicit supplementary letters of reference. Please send applications to the COMMITTEE ON STAFFING at the above address.

UC Irvine is an Affirmative Action/Equal Opportunity Employer.

UNIVERSITY OF CALIFORNIA, SAN DIEGO

An academic research position at the Assistant Research Engineer level is available at the Center of Excellence for Advanced Materials at University of California, San Diego. The Center specializes in high strain-rate deformation of solids and the successful candidate will lead the theoretical aspects of projects that pertain to the motion of dislocations. A Bachelor's degree in mathematics and background in the area of the mathematical treatment of dislocation dynamics in solids (including transient phenomena) are required. (Background can be obtained during educational program.)

Applications with three names of references should be submitted to: Professor S. Nemat-Nasser, Chairman of the Search Committee, the Center of Excellence for Advanced Materials, Department of AMES, R-011, UCSD, La Jolla, CA 92093, before March 31, 1990. Salary is in strict accordance

with University of California pay scales. If non-citizen, state immigration status.

The University of California, San Diego, is an equal opportunity/affirmative action employer.

COLORADO

**UNITED STATES AIR FORCE ACADEMY
DEPARTMENT OF MATHEMATICAL
SCIENCES
VISITING PROFESSOR**

The Department of mathematical Sciences of the United States Air Force Academy invites nominations and applications for a Visiting Professor position. We seek a Professor with extensive experience teaching undergraduate mathematics, statistics or operations research and a strong record of scholarly activity. Duties will include reviewing our academic programs, teaching undergraduate courses and promoting our research programs. Applicants should have a demonstrated commitment to undergraduate research and education. The appointment is usually for one year and will begin in July 1991. Inquiries are welcome for Visiting Professor positions for subsequent years. Salary is commensurate with qualifications. To apply, please send nominations (to include resume and references) by 1 May 1990 to: Chairman, Department of Mathematical Sciences, United States Air Force Academy, CO 80840-5701.

**UNIVERSITY OF COLORADO AT
COLORADO SPRINGS
DEPARTMENT OF MATHEMATICS
COLORADO SPRINGS, CO 80933-7150**

Applications are invited for 1 or 2 possible tenure track Assistant Professor positions for Fall 1990. Prefer areas consistent w/present research interests: algebra, diff. eq., computer vision, harmonic analysis, probability and math physics. Applicants should have significant research accomplishments or exceptional research promise and evidence of good teaching. Ph.D. is required. The average weekly teaching load is 7 1/2 hours. Generous support for faculty development such as travel, teaching off-loads and summer research. Send resume and 3 letters of reference to James E. Daly, Chairman. Screening will begin on Feb. 1, 1990 and continue until all positions are filled. AA/EEO.

DISTRICT OF COLUMBIA

NATIONAL SCIENCE FOUNDATION (NSF)

NSF's Division of Undergraduate Science, Engineering and Mathematics Education (USEME) is seeking candidates for Program Director positions in all NSF disciplines including: biology, chemistry, computer science, engineering, geosciences, mathematics and physics.

USEME was established within the NSF's Science and Engineering Education Directorate to serve as focal point for NSF's mission in undergraduate education. Programs will focus on key areas such as course and curriculum development, instrumentation and laboratory development, faculty enhancement, students, and major initiatives aimed at increasing participation in scientific careers of underrepresented groups such as women, minorities and the disabled.

Program directors in USEME are senior officers who take responsibility for identifying and characterizing national issues in undergraduate education, leading to the design, development and management of leadership activities and high leverage NSF programs. The Foundation relies heavily on program director intellectual capacity and judgement in the final decisions of the proposal and award process. USEME program directors serve as spokespersons for undergraduate education both across the entire Foundation, and to many important national communities.

Individuals are sought who can provide leadership and vision in USEME's mission to strengthen U.S. undergraduate education; who will establish direction to programs and provide technical and educational expertise for guiding the development of projects; and who themselves possess the knowledge and creativity to identify significant solutions to problems both within their disciplines and across the disciplines.

Applicants should have a Ph.D. or equivalent experience and 6 or more years of successful academic experience as a faculty member involved in teaching and research; in addition, academic administrative experience is preferred.

The positions will be filled by August 1990, on a one-or two-year rotational basis. The salary ranges from \$42,601 to \$67,112 per annum.

Applications should be submitted as soon as possible, but not later than April 15, 1990. Applicants should send resume to the National Science Foundation, Room 208, 1800 G Street, NW, Washington, DC 20550. Attn: Catherine Handle. For further information call 202/357-9681. Hearing impaired individuals should call 202/537-7492. For technical information, call Dr. Robert F. Watson, 202/357-9644. NSF is an Equal Opportunity Employer.

FLORIDA

FLORIDA ATLANTIC UNIVERSITY DEPARTMENT OF MATHEMATICS

Senior Position in Mathematics. Candidates should have an established research record and proven ability to attract external research support as well as interest in building a strong research group. Salary is competitive; teaching load does not exceed 2 courses per semester. Areas of research interest in the department include Algebra, Analysis, and Combinatorics. The department instituted a new Ph.D. program in 1988 and anticipates filling several junior positions in the next three years. The new senior person of the Department will be expected to play a major role in this program. Applicants from all fields are invited, but preference will be given to those candidates whose interests would enhance and complement existing research strength. Applications will be accepted until March 31. Send a letter of application and a curriculum vitae with description of research interests, and arrange for at least three letters of recommendation to be sent directly to:

Senior Search Committee Chairman
Department of Mathematics
Florida Atlantic University
Boca Raton, FL 33431

Florida Atlantic University is strongly committed to Affirmative Action and strongly encourages applications from minorities and women.

FLORIDA ATLANTIC UNIVERSITY DEPARTMENT OF MATHEMATICS

Applications are invited for two tenure track positions at the Assistant Professor level commencing August 1990. Candidates must possess a Ph.D., a strong commitment to research, and demonstrated teaching ability. Salary is competitive. Areas of research interest in the department include Algebra, Analysis, and Combinatorics. The department instituted a new Ph.D. program in 1988 and anticipates filling several positions in the next three years. Applicants from all fields are invited, but preference will be given to those candidates whose interests would enhance and complement existing research strength. Applications will be accepted until March 31. Send a letter of application, a detailed resume with description of research, and ask three people to send letters of recommendation to:

Recruiting Committee Chairman
Department of Mathematics
Florida Atlantic University
Boca Raton, FL 33431

Florida Atlantic University is strongly committed to Affirmative Action and strongly encourages applications from minorities and women.

FLORIDA INSTITUTE OF TECHNOLOGY

The Department of Applied Mathematics at Florida Institute of Technology, invites applications for two anticipated regular positions at associate and full professor levels in the area of nonlinear analysis, numerical and computational math, and statistics. Candidates should have a distinguished research record and a strong commitment to teaching. Qualified individuals are invited to send a vita and at least three reference letters to Professor V. Lakshmikantham, Head, Department of Applied Mathematics, Florida Institute of Technology, 150 W. University Blvd., Melbourne, FL 32901-6988. Florida Institute of Technology is an equal opportunity/affirmative action employer.

GEORGIA

VALDOSTA STATE COLLEGE

Two tenure-track positions in mathematics and one tenure-track position in mathematics education at the Asst./Assoc. Prof. level to begin September 1, 1990. Ph.D. required for math positions with special consideration given to applicants in analysis, probability or statistics, applied math and numerical methods. Terminal degree with strong math preparation in geometry required for math education position. A commitment to excellence in teaching and continued scholarly activity required.

Send letter of application and vita to:

John W. Schleusner, Head, Department of Mathematics and Computer Science, Valdosta State College, Valdosta, GA 31698. Application deadline: April 15, 1990, AA/EOE.

ILLINOIS

DEPAUL UNIVERSITY Department of Mathematical Sciences

Applications are invited for a tenure-track position at the assistant professor level beginning in September, 1990. A Ph.D. in Mathematics is required. We will consider strong candidates in any field of research. DePaul University is primarily an undergraduate institution. The Department of Mathematics has graduate programs in Mathematics Education

and Applied Mathematics. Strong commitment to teaching is essential. The teaching load is nine quarter courses/year but a reduction to seven quarter courses/year for research is possible. Applicants should send a vitae and 3-4 letters of recommendation, at least one of which pertains to teaching, to Hiring Committee, Department of Mathematics, 2219 N. Kenmore, Chicago, IL 60614. Women and minorities are encouraged to apply.

IOWA

IOWA STATE UNIVERSITY

The Department seeks qualified applicants for tenure track positions at the assistant professor level in Discrete Mathematics and in Mathematical Biology and for a tenure track position at the associate or full professor level in Computational Mathematics or Numerical Analysis starting August 21, 1990. The successful applicant for the senior position will be expected to seek outside funding for his or her research and to interact scientifically with colleagues in other campus departments. There will be start up funds available for the successful applicant for each of the three positions.

We will begin the interview process January 15, 1990. However, we shall continue to accept applications after that date until the positions are filled.

A number of visiting positions in diverse areas are expected to be available also and applications for them are also encouraged.

Women and minorities are encouraged to apply. Iowa State University is an Affirmative Action/Equal Opportunity Employer.

Applications should be sent to Howard A. Levine, Chair, Department of Mathematics, Iowa State University, Ames, Iowa 50011.

KANSAS

JOHNSON COUNTY COMMUNITY COLLEGE

JCCC located in suburban Kansas City anticipates two entry level Instructor, Mathematics positions to begin August 1990. Will teach a variety of math courses ranging from Fundamentals of Math to Differential Equations. Teaching load will consist of 15 hours per semester. Master's in math or equivalent with bachelor's in math or computer science and 2 years teaching experience, and computer skills required. Community college teaching experience and experience delivering instruction via alternative methods or delivery preferred. Salary will be commensurate with experience and experience. Travel funds for international travel.

not available. Review of applications: April 2, 1990. Send letter of application, transcripts, and vita to Human Resources, JCCC, 12345 College, Overland Park, KS 66210. Non-discrimination employer/EOE.

MARYLAND

FROSTBURG STATE UNIVERSITY Department of Mathematics

Actuarial Science. Full-time, tenure track, Asst./Asso. Prof., Fall 1990. To teach 12 credits undergrad. math per sem., including upper level actuarial math. Give direction to new actuarial science major. Master's degree and undergrad. math teaching exper., exper. in actuarial science, & at least 1 actuarial exam passed, required. Doctorate, Associate Actuary in CAS or SOA, preferred. Rank and salary commensurate with credentials and exper. Teaching exper. & quality of teaching of prime concern. POSITION AVAILABILITY PENDING FINAL APPROVAL BY THE LEGISLATURE OF THE STATE OF MARYLAND. Direct questions to: Dr. Richard Weimer, Department Chair, (301) 689-4377. Send letter of interest, resume, transcripts & 3 letters of recommendation, by 03/31/90, to: Mr. C. Douglas Schmidt, Director of Personnel Services, Frostburg, MD 21532. Women/minorities encouraged to apply. AA/EOE.

MASSACHUSETTS

WORCESTER POLYTECHNIC INSTITUTE

The Department of Mathematical Sciences will have several tenure track positions at all levels for fall of 1990. These positions require a strong research record or potential and evidence of quality teaching. Fields of interest are numerical analysis, computational fluid mechanics, nonlinear PDE, optimization, control theory, optimal design, dynamical systems, applied discrete mathematics, operations research, and statistics/applied probability.

WPI, the nation's third oldest college of science and engineering, offers degrees through the Ph.D. The Mathematical Sciences Department currently offers an undergraduate and master's degree in applied mathematics. Worcester, Massachusetts is the second largest city in New England, approximately 40 miles west of Boston.

Interested applicants should send a curriculum vita to: Samuel M. Rankin, III, Head, Department of Mathematical Sciences, 100 Institute Rd., Worcester, MA 01609. Applications will be accepted until the positions are filled. EOE/AA.

MINNESOTA

UNIVERSITY OF MINNESOTA, DULUTH DEAN—COLLEGE OF SCIENCE AND ENGINEERING

Applications and nominations are invited for the position of the dean of the College of Science and Engineering. Desired starting date is September 1, 1990; however, starting date is negotiable.

THE UNIVERSITY: UMD is a land grant university with 621 full and part-time faculty, 7,391 students, and 650 staff members. It is a coordinate campus of the University of Minnesota located in an urban area of 90,000 on the shores of Lake Superior.

THE COLLEGE: There are eleven departments in the college: aerospace, biology, chemical processing engineering, chemistry, computer engineering, computer science, geology, industrial engineering, mathematics and statistics, military science, and physics. There are 107 full-time and part-time faculty, 1,625 undergraduate and 71 graduate students, and 37 civil service and professional staff members.

THE POSITION: As chief academic officer, the dean reports to the vice chancellor for academic administration and has leadership responsibilities in matters of the curriculum, budget, personnel, resource management, and external relationships.

The dean must be committed to the stated goals of the college:

- excellence in undergraduate education coupled with a positive student experience;
- support for and expansion of faculty scholarship;
- continued growth of graduate programs;
- the service and land-grant mission;
- expansion of cooperative external relationships.

QUALIFICATIONS: Qualified applicants must have an earned doctorate in science, mathematics, or engineering discipline and must present a record of academic and research accomplishment sufficient to warrant tenure in a senior faculty position in the college. Applicants must have administrative experience in higher education at the department head level or above with collegiate administrative experience desirable. Tenured Associate Professor: doctorate plus five years professional experience; professional distinction in research and writing and demonstrated effectiveness in teaching and advising. Tenured Professor: doctorate plus eight years professional experience; national reputation and demonstrated effectiveness in teaching and advising.

The successful candidate shall have demonstrated leadership, team-building, decision-making, and administrative management abilities. The search committee is looking for candidates with a strong record of scholarship,

arship, commitment to affirmative action and the development of faculty, students and staff, and effective interpersonal and communication skills.

The individual must be eligible for employment in the United States at time of application.

SALARY: Competitive and negotiable

THE APPLICATION: Interested persons are encouraged to write or call for more detailed written information. The application is due on April 10, 1990, and consists of 1) letter of application including a discussion of experiences and accomplishments relevant to this position, 2) a resume, and 3) the names, addresses, and phone numbers of three references.

Applicants, nominations, and inquiries are to be sent to:

Dr. Joseph A. Gallian Chair, CSE Dean Search Committee, 420D Darland Administration Bldg., University of Minnesota, Duluth, Duluth, MN 55812, Telephone: (218) 726-6349

The University of Minnesota is an equal opportunity educator and employer and specifically invites and encourages applications from women and minorities.

NEVADA

UNIVERSITY OF NEVADA, LAS VEGAS

The Department of Mathematical Sciences at the University of Nevada, Las Vegas has vacancies for Assistant/Associate/Full Professor in Mathematics/Statistics; three tenure-track positions and one lectureship (renewable one year appointment) to begin Fall 1990. Successful candidates will be expected to participate fully in a research/scholarship program, in undergraduate/graduate teaching, in the continuing development of the graduate program, and in departmental/university service. Lecturers teach 12 credits per semester. Qualifications: tenure-track positions require a Ph.D. in Mathematics, Statistics, or a related field. Areas of recruitment are Statistics, Mathematics (all areas), Applied Mathematics with training in Numerical Analysis, Computer Graphics and dynamical systems, and Computational Mathematics. The lectureship position requires an M.S. or M.A. in Mathematics or a related field. Rank and salary will be commensurate with the candidate's experience and qualifications.

The University of Nevada, Las Vegas is a growing urban university with an enrollment of approximately 16,000 students located in metropolitan Las Vegas. The University will house a supercomputer center funded by DOE beginning May 1990.

Applicants for the 1990 Fall appointments should submit a letter of application, a current resume, photocopies of transcripts, and four

letters of reference to the Search Committee, Department of Mathematical Sciences, University of Nevada, Las Vegas, Las Vegas, Nevada 89154. All files completed by April 15, 1990, will be considered in initial screening. Files completed after the deadline will be reviewed only if positions are not filled up. This advertisement supersedes the previous 1989 ad. Proof of Eligibility for U.S. Employment (under the Immigration Reform and Control Act of 1986) will be required prior to employment. AA/EOE

NEW JERSEY

RUTGERS UNIVERSITY, CAMDEN

The Mathematical Sciences Department seeks highly qualified applicants for an anticipated senior professorship position. Strong research credentials and commitment to teaching are necessities. Send resume, at least three letters of recommendation, and selected reprints to:

Search Committee
Mathematical Sciences Department
Rutgers University
Camden, NJ 08102

AA/EOE

NEW YORK

STATE UNIVERSITY OF NEW YORK AT BINGHAMTON

Department of Mathematical Sciences invites applications at all levels for an unexpected opening. Senior applicants must have an outstanding research record. Junior-applicants must show great research promise. All areas, including statistics and mathematical computer science will be considered. The department has a healthy doctoral program and an attractive future. Vita and letters of recommendation should be sent to: David L. Hanson, Chair, Dept. of Math. Sciences, SUNY-Binghamton, Binghamton, NY 13901. Screening of applications will begin on March 15, 1990. The State University of New York at Binghamton is strongly committed to affirmative action. We offer access to services and recruit students and employees without regard to race, color, sex, religion, age, disability, marital status, sexual orientation or national origin.

STATE UNIVERSITY OF NEW YORK/COLLEGE AT OLD WESTBURY FACULTY POSITION

Specialty in one of following preferred: mathematics education, algebra or statistics. Meaningful computing exper. desirable. Should be committed to excellence in teaching undergraduates & demonstrate research. Ph.D. required. Exper. in multicultural higher educ. institutions desirable. Tenure-track. Rank, salary commens. with exper. Begins Fall 1990. Resumes reviewed upon receipt. Applic. deadline Mar. 10. Send resume & names of 3 references to:

Office of personnel & Affirmative Action
Search Committee MATH
State University of New York/College at
Old Westbury
Old Westbury, NY 11568-0210
Affirmative Action/Equal Opportunity Employer

NORTH CAROLINA

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE DEPARTMENT OF MATHEMATICS, CHARLOTTE, NC 28223

Two tenure-track and one or more Visiting positions at Asst/Assoc/Full Prof. level in Mathematics and Statistics, and one senior Assoc/Full Prof. level in Math Education. Rank and salary depend on qualifications. A PH.D and a serious commitment to teaching and research are required. Preferred specialties are: Algebra, Analysis, Applied Mathematics, Math Education, Statistics, but strong candidates in all areas are encouraged to apply. Also possible are lecturer positions (one or two year renewable; MA/MS required). Send vitae, list of four references, and abstracts of current research to Prof. Hae-Soo Oh at the above address. Closing date: Feb. 2, 1990, but applications will be considered until the positions are filled.

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OHIO

THE OHIO STATE UNIVERSITY AT NEWARK Department of Mathematics

ASSISTANT PROFESSOR, MATHEMATICS—The Ohio State University at Newark is seeking an Assistant Professor for a full-time, tenure track position in the Mathematics Department. DUTIES INCLUDE: Teach undergraduate courses in Mathematics. Ability and willingness to teach elementary statistics course is desirable. Conduct research and render appropriate Campus, Departmental, and University service. QUALIFICATIONS

INCLUDE: Ph.D. in Mathematics. Some experience at the college or university level preferred. TERMS: Full-time, 9 month tenure track position. STARTING DATE: Autumn Quarter, 1990. STARTING SALARY: \$26,000-\$33,000; comprehensive benefits package. To assure consideration, send vita and three letters of reference written directly to the search committee by March 30, 1990 to the Chairperson, Mathematics Search Committee, c/o Coordinator, Human Resources, The Ohio State University at Newark, University Drive, Newark, OH 43055. OSU at Newark is an Equal Opportunity/Affirmative Action Employer.

OKLAHOMA

THE UNIVERSITY OF OKLAHOMA Applied Non-Linear Analysis Applied Mathematics Position (CAPS) Related

The University of Oklahoma seeks a (tenure track) Assistant Professor (or higher) with a specialty in Applied Non-Linear Analysis. Ph.D. in Mathematics is required. Experience in fluid dynamics and numerical and computational experience are desirable. Potential for excellence in mathematics teaching and research is required. Competitive Salary.

This position is expected to contribute to the mathematical support of the Center for Analysis and Prediction of Storms, A Science and Technology Center at the University of Oklahoma funded by the National Science Foundation.

Applicants should send a letter of application, a complete vita, and three letters of reference sent to: Andy R. Magid, Chair, Applied Analysis Search Committee, Department of Mathematics, University of Oklahoma, 601 Elm, Room 423, Norman, Oklahoma 73019-0315. Closing date for applications is December 20, 1989 and evaluations two weeks thereafter until the position is filled. The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

THE UNIVERSITY OF OKLAHOMA Department of Mathematics

Applications are invited for one or more positions at the Assistant Professor level (or higher) in Mathematics beginning in 1990. Candidates must have a Ph.D. degree, demonstrated excellence in research and potential for high-quality teaching. Candidates in all areas will be considered with preference given to research interests compatible with those of our current faculty. Duties include research, normally teaching credit hours per semester, and Departmental and University service appropriate to rank.

Salary and rank will be commensurate with qualifications and experience. There may also be visiting positions. Applicants should send their vita and have at least three letters of reference sent to Dr. Ruediger Landes, Search Committee Chair, Department of Mathematics, University of Oklahoma, 601 Elm, Room 423, Norman, Oklahoma 73019-0315. Initial screening begins December 15, 1989 and every two weeks thereafter. Applications will be accepted until the position(s) are filled. The University of Oklahoma is an Affirmative Action/Equal Opportunity Employer.

OREGON

SOUTHERN OREGON STATE COLLEGE ASHLAND, OR 97520 DEPARTMENT OF MATHEMATICS

The Mathematics Department anticipates two permanent tenure-track positions (one requiring a specialist in Applied Mth) and two one-year lecturer positions beginning Fall of 1990. A Doctorate in Mathematics is required for the tenure-track positions while a Master's degree is sufficient for the lecturer positions. Applicants must have a strong commitment to teaching undergraduate mathematics and have the equivalent of 1 year of college level teaching experience. Send applications by April 15, 1990, to: Dr. Ronald Steffani, Chairman, at the above address. SOSOC is an AA/EEO employer.

PENNSYLVANIA

LAFAYETTE COLLEGE DEPARTMENT OF MATHEMATICS EASTON, PA 18042

One-year visiting position at the rank of Assistant Professor (Ph.D. required) or Instructor beginning in late August, 1990. Teach 3 undergraduate mathematics courses per semester. Lafayette is a small (2000) highly selective private college offering liberal arts and engineering and located near Philadelphia and New York.

Send resume, 3 letters of reference, and telephone numbers (office and home) to the Chair, Mathematics Search Committee. Review of applications will begin 3/15/90 and continue until the position is filled. Lafayette College is an Equal Opportunity Employer. Women and minorities are encouraged to apply.

TEXAS

ANGELO STATE UNIVERSITY DEPARTMENT OF MATHEMATICS

Angelo State University is seeking applications for a tenure track position at the Assistant Professor level for Fall, 1990. Candidates must hold the Ph.D. degree in mathematics. Teaching load is twelve hours per semester at a nine-month salary of \$31,300 to \$34,621, depending upon academic qualifications and college teaching experience, plus opportunity for summer teaching at the same monthly salary rate, and other University benefits. Job requirements include ability to communicate effectively with undergraduate students, dedication to excellence in teaching, and strong commitment to high academic and professional standards. Inquiries should be directed to:

Dr. J. M. Bailey, Head
Department of Mathematics
Angelo State University
San Angelo, Texas 76909

Deadline is open but may be closed at any time after April 1, 1990.

Angelo State University has one of the most modern and attractive campuses in the nation and is fully accredited by the Commission on Colleges of the Southern Association of Colleges and Schools. The University student body of over 6,400 ranks first among regional universities and third among all state universities in Texas in the high percentile ranking of entering freshmen in their high school graduating classes. The University offers one of the largest and most distinctive academic scholarship programs in the nation which attracts outstanding students from throughout the world.

Angelo State University is an equal opportunity/affirmative action employer.

LAMAR UNIVERSITY Beaumont, Texas

The Department of Mathematics seeks applications for a tenure-track Assistant/Associate Professor position beginning Fall 1990. Applicants must hold an earned Ph.D., should be active researchers in analysis and/or applied mathematics, and have a strong commitment to teaching.

Lamar is a state supported educational and research institution of approximately 12,000 students. The Department, which is located within the College of Engineering, offers the B.A., B.S., and M.S. degrees in Mathematics and has 16 full-time faculty.

For the approximately 250,000 people in the Beaumont area, there are eight museums, a symphony orchestra, ballet, opera, and other theatrical productions. Other facilities

and events are found in Houston 85 miles west. Nearby outdoor recreational opportunities include two of the largest freshwater lakes in Texas, the Big Thicket National Preserve, four national forests, the Gulf of Mexico, and a large inland saltwater lake.

Salary and rank are commensurate with qualifications and experience. Send a resume and three letters of recommendation to: Dr. John R. Cannon, Chair, Department of Mathematics; Lamar University; P.O. Box 10047; Beaumont, TX 77710. Full consideration will be given to applications received before May 1, 1990. Lamar is an EEO/AA employer.

UNIVERSITY OF TEXAS AT SAN ANTONIO

The Division of Mathematics, Computer Science, and Statistics is accepting applications for a tenure track position at the assistant professor level in mathematics education. Applicants must have at least equivalent of a master's degree in mathematics, and a doctoral degree in mathematics education or a related area. Preference will be given to those candidates with a commitment to research and whose research complements the interests of the current faculty and those with teaching experience at the public elementary or secondary level. Responsibilities include teaching, research, and program development.

Applicants should submit a resume and arrange to have three letters of recommendation sent to:

Chairperson, Search Committee
Division of Mathematics, Computer
Science, and Statistics
The University of Texas at San Antonio
San Antonio, TX 78285-0664

The closing date for this position is March 15, 1990.

UTSA is an Equal Opportunity/Affirmative Action Employer.

VIRGINIA

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY MATHEMATICAL PHYSICS

The Center for Transport Theory and Mathematical Physics at Virginia Tech anticipates a number of openings for visitors during academic year 1990-91. Applications in all areas of mathematical physics are invited for all or any parts of the year. There may also be possibilities of tenure-track appointments. Appointments may be made at any level, from postdoctoral up. Please send a curriculum vitae and a short description of research plans (for visiting positions only) and arrange for three letters of recommendation to be sent directly to Prof. P. F. Zweifel, Virginia

Polytechnic Institute and State University, CTTMP-212A Robeson Hall, Blacksburg, VA 24061-0435, USA. VA Tech is an EO/AA employer. Women and minorities are encouraged to apply.

AUSTRALIA

THE UNIVERSITY OF ADELAIDE SOUTH AUSTRALIA

Invites applications from both women and men for the following position: LECTURER/ SENIOR LECTURER IN PURE MATHEMATICS (Tenurable). (Ref: 6963) in the DEPARTMENT OF PURE MATHEMATICS. The Department of Pure Mathematics is engaged in teaching to the Honours degree level and maintains an active Ph.D. programme. The main research and teaching interests of the Department are in discrete mathematics, algebra, finite geometry, number theory, convexity, geometric analysis, differential and algebraic geometry, analysis and applications (including mathematical physics) and mathematics of communication. The Department has recently introduced new graduate certificates in the areas of communications and mathematical education.

Applicants should be effective undergraduate teachers and have proven research capability in Pure Mathematics. Applicants would normally be expected to be holders of a Ph.D. degree.

The position is available from 1 July 1990.

Further information concerning the duties of the position may be obtained from the Chairperson, Dr. D. Parrott, Department of Pure Mathematics, telephone (08) 228 5079.

It is University policy to encourage women to apply for consideration for appointment to tenurable academic appointments. Holders of full-time tenured or tenurable academic appointments have the opportunity to take leave without pay on a half-time basis for a specific period of up to ten years when this is necessary for the care of children.

INFORMATION about the general conditions of appointment and selection criteria may be obtained from the Senior Assistant Registrar (Personnel) at the University.

SALARY per annum: Lecturer: A\$32,197 x 7-A\$41,841; Senior Lecturer: A\$42,703 x 5-A\$49,529

APPLICATIONS, IN DUPLICATE, quoting reference number 6963 and giving full personal particulars (including whether candidates hold Australian permanent residency status), details of academic qualifications and names and addresses of three referees should reach the Senior Assistant Registrar (Personnel) at the University of Adelaide, GPO Box 498, Adelaide, South Australia 5001.

Telex UNIVAD AA 89141, Facsimile (08) 224 0464 not later than 30 April 1990.

The University reserves the right to make enquiries of any person regarding any candidate's suitability for appointment, not to make an appointment or to appoint by invitation.

THE UNIVERSITY OF ADELAIDE IS AN EQUAL OPPORTUNITY EMPLOYER.

CANADA

SIMON FRASER UNIVERSITY

The Department of Mathematics and Statistics of Simon Fraser University invites applications for a tenure track position in Mathematics at the Assistant Professor level starting September 1, 1990 or as soon thereafter as feasible (this position is subject to final budget approval). Applicants will be expected to have completed a Ph.D. degree at the time of appointment and to have demonstrated a strong teaching and research potential. Applicants should have research interests in the areas of Algebra and/or Discrete Mathematics. Applications, including curriculum vitae, should be sent to: Dr. A. R. Freedman, Chair, Department of Mathematics and Statistics, Simon Fraser University, Burnaby, BC V5A 1S6 Canada. Please arrange for three letters of reference to be sent directly from the referees. The deadline for applications is April 30, 1990. In accordance with Canadian immigration requirements, this advertisement is directed in the first instance to Canadian citizens and permanent residents of Canada, however, other qualified persons are encouraged to apply. Applications from women and minority groups are particularly welcome.

THE NETHERLANDS

UNIVERSITY OF UTRECHT, THE NETHERLANDS

The University of Utrecht is looking for a full-time Professor in pure mathematics in the department of mathematics, faculty of mathematics and computer science.

The tasks of the professor will be: - carrying out research in pure mathematics, supervision of PhD students - participation in both the general and specialized teaching duties of the department - contribution to the organizational work of the faculty

Qualifications: The to be appointed professor will be an expert in a central and important part of pure mathematics. The actual area of specialization is less important than general scientific qualities, capacity to stimulate, and the ability to bring different areas of mathematics into contact. Candidates

should have an international reputation and a broad knowledge of recent developments.

Non Dutch-speakers should be prepared to learn this language so that teaching can be done in Dutch within two years. The University of Utrecht would like to employ more women and in the case of otherwise equal suitability a woman will be appointed.

Starting date: This position will become vacant at the retirement of Prof. T.A. Springer. The new professor will take the chair on 1 March 1991.

Salary: According to Dutch civil service scale B for university professors (from 7.783, - to fl. 12.115, - per month gross).

Information: Can be obtained from the chairman of the search committee, Prof. J. Duistermaat (tel. -31-30-531513, -31-30-531430); email Duis@math.ruu.nl.

Applications: Should be accompanied by a curriculum vitae and a list of publications and sent within four weeks of the appearance of this advertisement to the vice-dean of the Faculty of Mathematics and Computer Science, Prof. J. van Leeuwen, P.O. Box 80.010, 3508 TA Utrecht; email Duis@math.ruu.nl. Please mention the reference number vac. 478./62013.

Persons who would like to draw the attention of the search committee to possible candidates are warmly invited to write to the chairman.

With equally qualified applicants preference will be given to a woman.

UNITED KINGDOM

UNIVERSITY OF STIRLING Division of Computing Science and Mathematics Chair in Mathematics and its Applications

This new Chair is in the School of Accountancy, Business, Computing and Economics. Candidates should be mathematicians who can develop the applications of Mathematics within the School, and within the University generally. Relevant research interests include Applied Combinatorics, Operational Research and Statistics. The successful candidate will provide academic leadership, and will promote mathematicians in the Division, and will promote new growth in mathematics in the University. A new multi-disciplinary programme in Mathematics and its Applications is planned for Autumn 1990, to be supported by temporary lecturing appointments.

Stirling is a young and active University in Central Scotland, with an attractive campus. The appointment will be on the Professorial salary scale.

Applications in the form of a CV should include the names of 3 referees, should be sent to the University Secretary.

Department of Mathematics

The Department of Mathematics invites applications for tenure-track and visiting faculty positions at all ranks and in all areas of mathematics beginning in August 1990. The Department is in the third year of a major development program intended to build nationally recognized research groups of four to seven faculty members in Computational Mathematics, Differential Equations (including PDE's), Discrete Mathematics, Dynamical Systems, Operator Theory, Algebraic Geometry and Number Theory, Systems and Control and Probability and Statistics. During the past two years, 12 tenure-track or tenured appointments have been made and we anticipate making at least 5 appointments during each of the next three academic years.

For 1990, the majority of the tenure-track appointments will be made at the Assistant Professor level. To be considered for such an appointment, the candidate must demonstrate potential for outstanding research while providing effective teaching at both the undergraduate and graduate levels in a public university environment. For candidates at the Associate Professor level, additional requirements include a proven record of outstanding research accomplishments and versatile and effective teaching. At the Full Professor level, applicants should be recognized nationally for the quality and scope of their research and leadership activities. Salaries are competitive and commensurate with experience and qualifications.

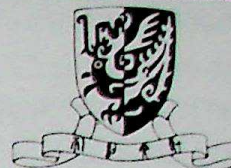
In support of its research and graduate education programs, the Department has installed an Advanced Computing Facility centered around a network of Titan Mini-Super Graphics computers plus a cluster of Work Stations. Research efforts were enhanced by direct access to the University's CRAY XMP-14/se and IBM 3090-500E/VF super computers.

Arizona State University has more than 43,000 students and is located in the rapidly growing Phoenix Metropolitan area—a center of business, finance and high technology. The valley offers a wide range of educational, cultural and recreational opportunities. Pleasant and convenient housing is widely available near the university campus.

Applications should be received by December 1, 1989, and the Department will begin to review applications as of this date. The deadline will be extended on a month-to-month basis until all available positions are filled.

Applicants should send their resumés and arrange for at least three letters of recommendation to be sent to: William T. Trotter, Chair, Department of Mathematics, Arizona State University, Tempe, AZ 85287-1804. AA/EOE

ARIZONA STATE UNIVERSITY



THE CHINESE UNIVERSITY OF HONG KONG

Professor of Mathematics

(Ref. no. 110/509/2/89)

The University

The University offers comprehensive programmes of studies up to PhD level in the Humanities, Business Administration, Science, Medicine, Social Science, Education, Engineering and from 1991 Architecture. The University currently has over 7,700 full-time equivalent students and a major expansion in the next three years is expected. The University is very active in promoting research and development and liaising with industry and the business sector worldwide. Both English and Chinese are used in teaching and administration.

The Professorship

A Professor is at the top of the University teaching profession. By virtue of his/her distinguished scholarship, prominent contributions and invaluable service in the academic discipline concerned, he/she is expected to provide leadership to the teaching and research programmes in his/her field and play a major part in the planning and development of his/her academic discipline. Candidates for the post should have excellent academic qualifications, extensive university teaching and relevant research experience and have published scholarly works of originality and merit.

Remuneration and Benefits

The University offers a competitive remunerative package. Salary will be commensurate with qualifications and experience, with a minimum of HK\$43,210 per month. For superannuable appointment, benefits will include long leave with full-pay at the rate of one-sixth of the period of service, contributory superannuation scheme (University 15%, appointee 5%), medical care, education allowances for children, housing benefit (with appointee contributing 7.5% of salary towards rental) and leave passage benefits for appointee and dependants. Appointment may also be made on a variety of fixed-term contracts with equivalent benefits including a contract-end gratuity. Fringe benefits will be packaged flexibly including cash payment options subject to mutual agreement. Retirement age is 60 but appointment may be extended beyond 60 subject to mutual agreement.

Application Procedure

Application, together with full resume and the names and addresses of three referees, should be forwarded to the Secretary of the University, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong by April 30, 1990. Please quote the reference number and mark 'Recruitment' on cover. Applications submitted after April 30, 1990 may also be considered if the post or comparable posts are available.

PUBLICATIONS WANTED

of Stirling, Stirling FK9 4LA, Tel 0786 73171, extension 2250, from whom further particulars are available, by 31 March 1990.

Wanted: Mathematical books, journals, reprints, ephemera. Contact R. K. Dennis, Math. Dept., White Hall, Cornell U., Ithaca, NY 14853-7901. Tel: 607-255-4027, FAX: 607-255-7149. e-mail: dennis@msun7.msi.cornell.edu

SITUATIONS WANTED

TEACHING MATHEMATICIAN. PH.D 1982. AGE 38

Speciality: Differential Equations. 5 published articles. 15 years experience in teaching and research in U.S.A. and abroad. Excellent students and peer evaluations of classes. References and résumé available upon request. Available immediately. M. Abbassi, 500 Tulip Rd., State College, PA 16801

Mathematician with 15 years experience in teaching and research is seeking a (possibly temporary) position. Ph.D. 1978, Analysis and Operator Theory, 20 publications. Available July 1990. Fluent Russian. Respond to applicant, Code 920, Advertising Department, AMS, P.O. Box 6248, Providence, RI 02940.

The following are the 52 mathematicians who signed the letter which appears on page 263 concerning the June 4, 1989 massacre in Beijing, China.

William B. Arveson	Henry Helson	Richard S. Palais
Michael F. Atiyah	Heisuke Hironaka	Murray H. Protter
Hyman Bass	Wu-chung Hsiang	A. Schatz
Lipman Bers	Wu-yi Hsiang	Michael Schneider
Lenore Blum	Junn T. Hwang	Richard M. Schoen
Armand Borel	Victor Kac	Bernard Shiffman
Raoul Bott	Anatole Katok	Katsuhiko Shiohama
James H. Bramble	Jerry L. Kazdan	Yum-Tong Siu
Robert Freeman Brown	Robion C. Kirby	Stephen Smale
Andrew J. Casson	Joseph J. Kohn	Frank L. Spitzer
Sun-Yung Alice Chang	Tsit-Yuen Lam	Elias M. Stein
John P. D'Angelo	Thomas M. Liggett	Chuu-Lian Terng
Peter L. Duren	Saunders Mac Lane	Francois Trèves
Richard T. Durrett	Anil Nerode	Alan D. Weinstein
Edward G. Effros	Junjiro Noguchi	Guido L. Weiss
Doris Fischer-Colbrie	Takushiro Ochiai	Hung-Hsi Wu
Wolfgang H. Fuchs	O. Timothy O'Meara	Paul C. Yang
Ian Graham		

University of Wyoming
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The course will address selected important and recent developments in discrete mathematics. The goal is to more quickly incorporate such modern discoveries in this rapidly expanding field into college courses at all grade levels. Many new advances are in fact highly suitable for enrichment and modernizing basic courses. Both fundamental theoretical results and contemporary applications will be covered. Some of the topics to be included are: developments on the marriage problem and fair division schemes, Hamiltonian cycles for binary trees (the Catalan numbers), the famous labeling lemmas of Sperner and Tucker with applications to labeling and path following algorithms for finding equilibrium and fixed points, the combinatorial structure for power indices in political science, and combinatorial aspects of polytopes.

PREREQUISITES: Familiarity with basic linear algebra and some exposure to elementary discrete mathematics is desirable.

SPEAKERS: William F. Lucas, The Claremont Graduate School, will lecture during the three weeks. Carl W. Lee, The University of Kentucky, will lecture throughout one week. A few additional lectures will be presented by distinguished experts in the subject.

ADMISSION AND SCHOLARSHIPS: Entry into the summer school is restricted, but is without charge to those who are qualified and are admitted. National Science Foundation funding which consists of a stipend plus living costs is available for selected faculty. A limited number of scholarships, covering living costs, are available for qualified graduate students. For further information and application forms, please write to:

Professor A. Duane Porter - Mathematics Department
Box 3036 - University of Wyoming
Laramie, Wyoming 82071



UNIVERSITY OF CAPE TOWN
Dept of Applied Mathematics:
Senior Lecturer/Lecturer

Applications are invited for the above post. The field of interest is unrestricted, though the Department is keen to strengthen and complement its existing interests in Numerical Analysis, Differential Equations and Variational Methods, Continuum Mechanics, Biomathematics and General Relativity.

A negotiable salary package includes attractive staff benefits such as medical aid, a pension scheme and a housing subsidy in certain circumstances. Further details concerning remuneration will be sent to applicants on request.

The rank of the successful incumbent will be decided upon on the basis of qualifications and experience; applicants should indicate in their letters of application the rank at which they wish to be considered.

A full curriculum vitae, and the names, addresses and telephone numbers of three referees, should be submitted not later than 28 February 1990 (late applications will be considered up to 30 March 1990), to the Appointments Officer, (ref. N.P.) University of Cape Town, Rondebosch 7700, Republic of South Africa, (telephone: (21) 650-2192; telefax: (21) 650-2138). Further information may be obtained from the above, or from the Counsellor, Science and Technology, South African Embassy, Suite 350, 4801 Massachusetts Avenue, NW Washington DC 20016.

The firm policy and practice of the University of Cape Town is to oppose discrimination in any sphere of university life on grounds of gender, race or creed. UCT has consistently protested, and continues to protest, against apartheid laws and practices and is committed to a just future for our country. Information on this is available on request.

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NEW LISTING

MATHEMATICAL REVIEWS ASSOCIATE EDITOR

Applications and recommendations are invited for a two-year appointment as Associate Editor of Mathematical Reviews (MR), to commence in the summer of 1990. Applications are particularly welcomed from persons taking leave from other positions, and it is possible to combine this position with a sabbatical leave. At this time one (or possibly two) positions are available. The ability to write good English is essential, and the ability to read mathematical articles in other languages is very important.

Persons with considerable breadth in mathematics (especially persons in applied mathematics) are sought at this time. The responsibilities of an Associate Editor include selecting articles suitable for review, classifying them, assigning them to reviewers, editing the reviews when they are returned, and correcting galley proofs.

The MR office of the American Mathematical Society is located in Ann Arbor, Michigan, not far from the campus of the University of Michigan, and the editors (although employees of the AMS) enjoy many privileges at the university. The twelve-month salary is negotiable; salary and fringe benefits are similar to those in universities.

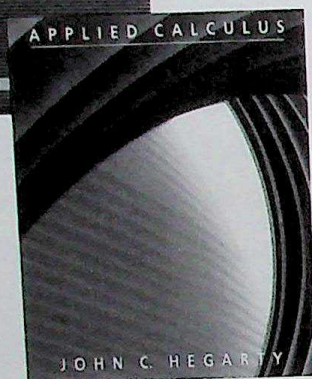
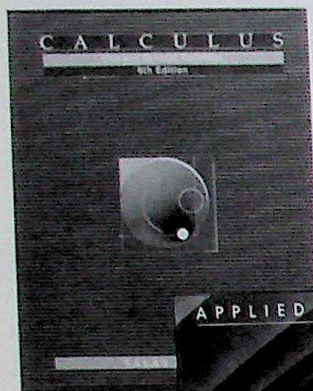
Applications (including curriculum vitae, bibliography, and names and addresses of at least three references) and recommendations should be sent to Dr. R.G. Bartle, Executive Editor, Mathematical Reviews, P.O.Box 8604, Ann Arbor, MI 48107-8604. (Telephone: 313-996-5255; Fax: 313-996-2916; INTERNET: RGB@MATH.AMS.COM) Inquiries are invited.

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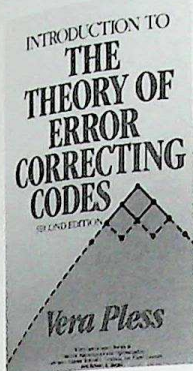
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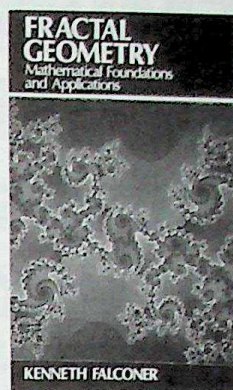
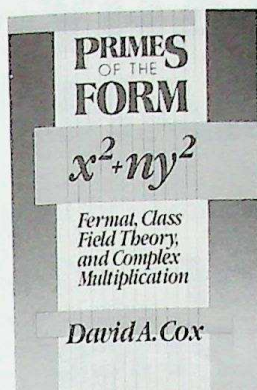
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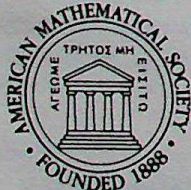
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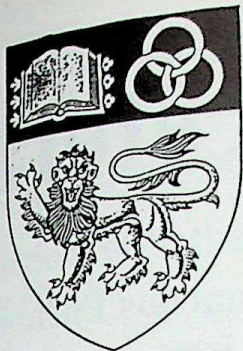
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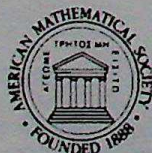
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- 16 Associative rings and algebras
- 17 Nonassociative rings and algebras
- 18 Category theory, homological algebra
- 19 K-theory
- 20 Group theory and generalizations
- 22 Topological groups, Lie groups
- 26 Real functions
- 28 Measure and integration
- 30 Functions of a complex variable
- 31 Potential theory
- 32 Several complex variables and analytic spaces
- 33 Special functions
- 34 Ordinary differential equations
- 35 Partial differential equations
- 39 Finite differences and functional equations
- 40 Sequences, series, summability
- 41 Approximations and expansions
- 42 Fourier analysis
- 43 Abstract harmonic analysis
- 44 Integral transforms, operational calculus
- 45 Integral equations
- 46 Functional analysis
- 47 Operator theory
- 49 Calculus of variations and optimal control; optimization
- 51 Geometry
- 52 Convex sets and related geometric topics
- 53 Differential geometry
- 54 General topology
- 55 Algebraic topology
- 57 Manifolds and cell complexes
- 58 Global analysis, analysis on manifolds
- 60 Probability theory and stochastic processes
- 62 Statistics
- 65 Numerical analysis
- 68 Computer science
- 70 Mechanics of particles and systems
- 73 Mechanics of solids
- 76 Fluid mechanics
- 78 Optics, electromagnetic theory
- 80 Classical thermodynamics, heat transfer
- 81 Quantum mechanics
- 82 Statistical physics, structure of matter
- 83 Relativity
- 85 Astronomy and astrophysics
- 86 Geophysics
- 90 Economics, operations research, programming, games
- 92 Biology and behavioral sciences
- 93 Systems theory; control
- 94 Information and communication, circuits

MONO

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Please read the following to determine what membership category you are eligible for, and then indicate below the category for which you are applying.

For **ordinary members** whose annual professional income is below \$43,000, the dues are \$70, for those whose annual professional income is \$43,000 or more, the dues are \$92.

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For a **joint family membership**, one pays ordinary dues, based on his or her income, and the other pays ordinary dues based on his or her income, less \$20. (Only the member paying full dues will receive the Notices and the Bulletin as a privilege of membership, but both members will be accorded all other privileges of membership.)

Minimum dues for **contributing members** are \$138.

For either **students** or **unemployed individuals**, dues are \$23, and annual verification is required.

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Members can purchase a **multi-year membership** by prepaying their current dues rate for either two, three, four or five years. This option is not available to either unemployed or student members.

1990 Dues Schedule

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CMS Cooperative rate	<input type="checkbox"/> \$60 <input type="checkbox"/> \$78
Joint family member (full rate)	<input type="checkbox"/> \$70 <input type="checkbox"/> \$92
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Contributing member (minimum \$138)	<input type="checkbox"/>
Student member (please verify) ¹	<input type="checkbox"/> \$23
Unemployed member (please verify) ²	<input type="checkbox"/> \$23
Reciprocity member (please verify) ³	<input type="checkbox"/> \$46 <input type="checkbox"/> \$70 <input type="checkbox"/> \$92
External member	<input type="checkbox"/> \$49
Multi-year membership	\$ for years

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3 Reciprocity Membership Verification (sign below) I am currently a member of the society indicated on the right and am therefore eligible for reciprocity membership.

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- ☐ Asociación Matemática Española
- ☐ Australian Mathematical Society
- ☐ Berliner Mathematische Gesellschaft e.V.
- ☐ Calcutta Mathematical Society
- ☐ Dansk Matematisk Forening
- ☐ Deutsche Mathematiker-Vereinigung e.V.
- ☐ Edinburgh Mathematical Society
- ☐ Gesellschaft für Angewandte Mathematik und Mechanik
- ☐ Glasgow Mathematical Association
- ☐ Indian Mathematical Society
- ☐ Iranian Mathematical Society
- ☐ Irish Mathematical Society
- ☐ Íslenska Staerðfræðafélagið
- ☐ Israel Mathematical Union
- ☐ János Bolyai Mathematical Society
- ☐ Korean Mathematical Society
- ☐ London Mathematical Society
- ☐ Malaysian Mathematical Society
- ☐ Mathematical Society of Japan
- ☐ Mathematical Society of the Philippines
- ☐ Mathematical Society of the Republic of China
- ☐ New Zealand Mathematical Society
- ☐ Nigerian Mathematical Society
- ☐ Norsk Matematisk Forening
- ☐ Österreichische Mathematische Gesellschaft
- ☐ Polskie Towarzystwo Matematyczne
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- ☐ Ramanujan Mathematical Society
- ☐ Real Sociedad Matemática Española
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- ☐ Sociedade Brasileira Matemática
- ☐ Sociedade Brasileira de Matemática Aplicada e Computacional
- ☐ Sociedade Paranaense de Matemática
- ☐ Sociedade Portuguesa de Matemática
- ☐ Societat Catalana de Matemàtiques
- ☐ Société de Mathématiques Appliquées et Industrielles
- ☐ Société Mathématique de Belgique
- ☐ Société Mathématique de France
- ☐ Société Mathématique Suisse
- ☐ Southeast Asian Mathematical Society
- ☐ Suomen Matemaattinen Yhdistys
- ☐ Svenska Matematikersamfundet
- ☐ Union Matemática Argentina
- ☐ Unione Matematica Italiana
- ☐ Vijnana Parishad of India
- ☐ Wiskundig Genootschap

Letters to the Editor

Confidentiality

The Supreme Court, in a decision on a case against the University of Pennsylvania by the Equal Employment Opportunity Commission, has ruled that confidential scholarly assessments of the work of a candidate for tenure at a University must be disclosed to Federal Investigators.

This step is a clear violation of confidentiality, basic to the maintenance of quality at Universities. In consequence, I will therefore decline to write my letters to Universities about the work of candidates for tenure. I recommend such action as the only proper response to this attack on academic freedom.

Saunders Mac Lane
University of Chicago
(Received January 18, 1990)

Boycotting Scientific Visits to China

Editor's Note: The letter by Professors Fuchs and Wu referred to in the following letter is the letter titled *Boycotting Scientific Visits to China* in the March 1990 issue of *Notices* page 263. That letter, signed by 52 mathematicians, was submitted for publication by Professors Fuchs and Wu.

The January issue of *Notices* contained a letter which I wrote about boycotting scientific visits to China. I would like the opportunity to modify my position and correct misimpressions evidently created by it.

First, my letter was written in response to a letter by Professors Fuchs and Wu that was, unfortunately, not published in the same issue.

Second, I see that there are many people within our community who would like to return to "business as usual" with regard to China, and

I certainly never intended to lend support to that viewpoint.

Third, when I wrote I was thinking of different times, when repression in the USSR was as much of an issue as it is in China today. During that period I was one of many individuals who visited the USSR, combining scientific trips with visits to the Moscow Refusnik Scientific Seminar. I like to think that our visits, support and friendship were among the factors which ultimately lead to the release of many (but not all) members of that oppressed group. However, China in 1990 is not the USSR circa 1971.

On the balance, I find that I agree much more with Professors Fuchs and Wu than with many of those who are now lending support to the present administration in China, and withdraw my earlier opposition to boycott.

Joan S. Birman
Columbia University
(Received February 12, 1990)

Rumanian Mathematicians Ask for Help and Cooperation

The revolution in Romania, an historical act of the whole people, makes possible the direct contact between the mathematicians in this country and those in foreign countries. These contacts could be as follows:

1. exchanges of didactic and scientific literature,
2. exchanges of professors, researchers and students,
3. long-term contracts on common scientific research.

Because of the lack of free convertible currency, the financial basis of all these contacts should be barter-type relations.

The aim of this letter is to inform the Mathematical Community in the World about these new possibilities and to involve it in these forms of help and cooperation. Everybody who is interested in the development of mathematics "as a vibrant, living discipline ready to engage their

minds and careers in a stimulating contemporary challenge" should help it with his own efforts.

Now, Rumanian mathematicians need:

1. the latest (good) books in the field of mathematics and specialized reviews (lithographed or published),
2. rapid copying apparatus (xerox),
3. computers and specialized teaching programs,
4. grants of 1-6 months for those professors and researchers who want to learn what is new in education and in mathematics,
5. grants for doctorates.

Over 100 mathematicians work in the Polytechnic Institute of Bucharest and all are open-minded and willing to make progress in mathematics.

Policy on Letters to the Editor

Letters submitted for publication in *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule normally requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of *Notices* in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in *Bulletin of the American Mathematical Society* will be considered for publication. All published letters must include the name of the author.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, and will be acknowledged on receipt.

The fields of our didactic and scientific interests are: mathematical education, mathematical logic, algebraic geometry, linear and multilinear algebra, real functions, measure and integration, functions of complex variables, special functions, ordinary differential equations, partial differential equations, Fourier analysis, operational calculus, integral equations, functional analysis, operator theory, optimization, differential geometry, analysis on manifolds, probability theory, statistics, numerical analysis, mechanics, and control systems. Unfortunately, with very few exceptions, we were unable to participate in international meetings, conferences, congresses, and summer seminars on mathematics held abroad.

Finally, as a member of the American Mathematical Society and of the Society of Mathematical Sciences of Romania, I suggest establishing reci-

procity agreements between these associations.

Constantin N. Udriste
Polytechnic Institute
Bucharest, Romania

(Received January 22, 1990)

A Simple Proposal for Federal Support of Mathematicians

On page 135 of the February 1990 issue of *Notices* the federal support of Mathematics, NSF and Non NSF, in FY 1990 is given as \$147,100,000. Let's round it off to 150 million. This would support 10,000 research mathematicians at \$15,000 each. Who is a "research mathematician"? One who publishes mathematics articles in research journals. If there are more than 10,000 such people just support the "top" 10,000 (count papers or pages).

Is this scheme fair? No. A Gödel might be missed. New Ph.D.s would

compete with experienced people. A variant of this scheme would be to support all new Ph.D.s for, say, 5 years, perhaps at some lower level and divide the remaining funds (above.) Although this scheme is not completely fair (does there exist a completely fair scheme?) I suggest that it is **fairer** than the current distribution system by several orders of magnitude. For one thing it utilizes the refereeing system for research papers which, with all its faults, works much, much better than the current grant distribution system.

It is worth noting one feature of this simple proposal: research funds go to research people. In contrast, the current system funds a small army of beaurocrats, including Secretaries and Deans, most of whom do no research at all.

Anton Z

Northern Illinois University

(Received February 8, 1990)

WEAK CONVERGENCE METHODS FOR NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS

Lawrence C. Evans

(CBMS Regional Conference Series, Number 74 • Supported by the National Science Foundation)

The purpose of this book is to explain systematically and clearly many of the most important techniques set forth in recent years for using weak convergence methods to study nonlinear partial differential equations. This work represents an expanded version of a series of ten talks presented by the author at Loyola University of Chicago in the summer of 1988.

The author surveys a wide collection of techniques for showing the existence of solutions to various nonlinear partial differential equations, especially when strong analytic estimates are unavailable. The overall guiding viewpoint is that when a sequence of approximate solutions converges only weakly, one must exploit the nonlinear structure of the PDE to justify passing to limits. The author concentrates on several areas that are rapidly developing and points to some underlying viewpoints common to them all. Among the several themes in the book are the primary role of measure theory and real analysis (as opposed to functional analysis) and the continual use in diverse settings of low amplitude, high frequency periodic test functions to extract useful information. The author uses the simplest problems possible to illustrate various key techniques.

Aimed at research mathematicians in the field of nonlinear PDEs, this book should prove an important resource for understanding the techniques being used at the forefront of this vital area of research.

1980 *Mathematics Subject Classifications*: 35, 46

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Rademacher on $J(\tau)$, Poincaré Series of Nonpositive Weights and the Eichler Cohomology

Marvin I. Knopp

Dedicated to Paul T. Bateman

This article is the twenty-second in the series of Special Articles published in the *Notices*. Marvin I. Knopp received the Ph.D. degree in 1958 from the University of Illinois (Urbana). His dissertation, written under the direction of Paul T. Bateman, dealt with modular forms of nonpositive weights. He has continued to study modular forms, focusing upon their Fourier coefficients, the Eichler cohomology theory and the theory of modular integrals and their Mellin transforms. He has held professorships at the University of Wisconsin, the University of Illinois at Chicago Circle, Bryn Mawr College and has been a Professor of Mathematics at Temple University since 1976.

I. Introduction.

1. Rademacher's perspective upon $J(\tau)$.

In 1939 Hans Rademacher presented a new construction of the modular invariant $J(\tau)$ in a seminal—yet little known—paper. This note examines Rademacher's construction from the perspective of a half-century of further advances in the theory of modular and automorphic forms. Especially important is the connection with the Eichler cohomology theory [3], developed some twenty years later.

The modular group $\Gamma(1)$, is the group of linear fractional transformations $V\tau = (a\tau + b)/(c\tau + d)$, τ complex, with $a, b, c, d \in \mathbb{Z}$ (\mathbb{Z} is the set of rational integers) and $ad - bc = 1$. The *absolute modular invariant* $J(\tau)$ is defined, for τ in the upper half-plane \mathcal{H} , by

$$(1) \quad J(\tau) = 20G_4(\tau)^3 / (20G_4(\tau)^3 - 49G_6(\tau)^2),$$

with

$$(2) \quad G_k(\tau) = \sum'_{m,n \in \mathbb{Z}} (m\tau + n)^{-k}, \quad k \in \mathbb{Z}, k \geq 3,$$

the Eisenstein series of weight k . (The notation \sum' indicates omission of the term for $m = n = 0$.) The well-known behavior of $G_k(\tau)$ under $\Gamma(1)$ implies directly that $J(\tau)$ is invariant with respect to $\Gamma(1)$: $J(V\tau) = J(\tau)$, for

all τ in \mathcal{H} and $V \in \Gamma(1)$. (See [1, Chapter 1], [32, Chapter 3] and §I.2). Furthermore, among modular invariants $J(\tau)$ has the distinction that it generates the whole field of modular functions over the complex field \mathbb{C} [17, Theorem 1E, p. 345]. It has the Fourier series expansion

$$(3) \quad 12^3 J(\tau) = e^{-2\pi i \tau} + 744 + \sum_{n=1}^{\infty} c_n e^{2\pi i n \tau}, \quad \tau \in \mathcal{H},$$

where the c_n are rational integers [33, p. 56].

In 1938 Rademacher, unaware that Petersson [25] had already done so, published an exact formula for c_n [30]. (For specifics see (12).) Starting with that formula, in [31] he adopts an entirely fresh viewpoint concerning $J(\tau)$, taking it to be *defined* (anew) by (3) and the exact formula (12). He poses the problem: to show *from this new definition* that $J(\tau)$ is a modular invariant. Since the two transformations $S\tau = \tau + 1$, $T\tau = -1/\tau$ generate $\Gamma(1)$ [12, p. 7] and since $J(\tau + 1) = J(\tau)$ follows directly from (3), this problem reduces (an odd word, considering the difficulty involved) to that of deriving, from (3) and (12) alone, the equation $J(-1/\tau) = J(\tau)$, now far from obvious. Rademacher solves this problem by carrying out a profound transformation of the function defined by (3) and (12), representing $J(\tau)$ as what we may now term a "modified Poincaré series."

2. Poincaré's construction of automorphic functions.

Poincaré series appear for the first time in Poincaré's celebrated 1882 memoir on Fuchsian functions [28]. They provide a perspective indispensable for understanding Rademacher's construction and the later work [8, 9, 10, 11, 21, 35] based directly upon it.

Poincaré deals with groups of linear fractional transformations acting on the unit disc, in particular, with the construction of their invariant functions. For consistency with our introductory remarks we consider instead groups Γ of linear fractional transformations acting on the upper half-plane \mathcal{H} ; that is, we assume that Γ is a discrete group of mappings $V\tau = (a\tau + b)/(c\tau + d)$, with a, b, c, d real and $ad - bc > 0$. If Γ is finite, it is an easy matter to construct a meromorphic function

$F(\tau)$, *automorphic* (that is, invariant) with respect to Γ , by forming the finite sum

$$(4) \quad F(\tau) = \sum_{V \in \Gamma} f(V\tau),$$

with f chosen meromorphic in \mathcal{H} . That F does not reduce to a constant can be guaranteed by a suitable choice of f .

When Γ is infinite, in contrast, this simple construction does not suffice, because the series in (4) may fail to converge. To overcome this difficulty, Poincaré introduced the series which bear his name:

$$(5) \quad F_k(\tau; f) = \sum_{V \in \Gamma} \frac{f(V\tau)}{(c\tau + d)^k}, \quad V\tau = (a\tau + b)/(c\tau + d);$$

in (5) f is a rational function and k a positive integer chosen large enough to guarantee absolute-uniform convergence of the series (5) in compact subsets of \mathcal{H} . (The existence of such k follows from the discreteness of Γ .) The function $F_k(\tau; f)$ so formed, while meromorphic in \mathcal{H} , fails to have the desired simple automorphic property

$$(6) \quad F(M\tau) = F(\tau), \quad \text{all } M \in \Gamma,$$

characteristic of functions F defined by (4). However, the absolute convergence of (5) implies readily that for all $M = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \in \Gamma$,

$$(7) \quad F_k(M\tau; f) = (c\tau + d)^k F_k(\tau; f),$$

since $(\gamma\tau + \delta)^k (cM\tau + d)^k = (c'\tau + d')^k$, where $c'\tau + d'$ is the lower row of VM . A function satisfying the transformation formulae (7) and certain regularity conditions is called an *automorphic form of weight k on Γ* . (We note that the Eisenstein series $G_k(\tau)$, defined by (2), is virtually the same as the Poincaré series (5), with $f \equiv 1$ and $\Gamma = \Gamma(1)$. In any event, $G_k(\tau)$ is a modular form—that is an automorphic form on $\Gamma(1)$ —of weight k , since $G_k(\tau)$ satisfies (7) for $M \in \Gamma(1)$.) A function satisfying (6) is called an *automorphic function on Γ* .

To reach his original goal, construction of nontrivial meromorphic functions possessing the (absolute) invariance property (6) with respect to Γ , Poincaré forms the quotient $F_k(\tau; f_1)/F_k(\tau; f_2)$, with rational f_1 and f_2 chosen to have distinct singularities in \mathcal{H} . The latter condition ensures that this quotient does not reduce to a constant.

This work of Poincaré on the problem of constructing automorphic (he called them “Fuchsian”) functions provides the context for the well-known story of his sudden revelation while stepping on a bus to go on an excursion, and in the midst of an unrelated conversation. The unexpected insight was the relationship of his (Poincaré)

series (5) to the rigid motions of hyperbolic geometry. This revelation took place immediately following a week period during which he thought intensely about the question, but with inconclusive partial results. Poincaré ultimately obtained a complete solution, but only after several further similar occurrences, equally unexpected and sudden. Of particular interest is Poincaré’s immediate recognition, in each instance, that the new idea would be fruitful, before working through any of the details. For Poincaré’s own account see [29, pp. 52–55]. There is a discussion of this episode as well in [5, pp. 12–15].

3. Elliptic functions and Eisenstein series.

A problem different in technical detail, but virtually identical in spirit, is one resolved before Poincaré’s birth: that of constructing elliptic functions, that is, say, functions meromorphic in the complex plane and automorphic with respect to a group of translations in two independent directions. Suppose ω_1 and ω_2 are complex numbers with $\text{Im}(\omega_1/\omega_2) \neq 0$. Then the “lattice” $L = \{m\omega_1 + n\omega_2 | m, n \in \mathbb{Z}\}$ is discrete in \mathbb{C} and when $k \geq 3$ the “Mittag-Leffler sum”,

$$(8) \quad E_k(z) = E_k(z; \omega_1, \omega_2) = \sum_{m, n \in \mathbb{Z}} \frac{1}{(z + m\omega_1 + n\omega_2)^k}$$

represents a function (in fact, the simplest one) with a pole of order k at each of the lattice points. When $k \geq 3$ the series (8) obviously converges to a function meromorphic in \mathbb{C} , but much more is true. The Mittag-Leffler construction, designed only to produce meromorphic functions with poles at a prescribed discrete set of points (with prescribed principal parts, as well), actually yields elliptic functions invariant with respect to the group $G = G(\omega_1, \omega_2) = \{z \rightarrow z + \omega | \omega \in L\}$. This obtains since (8) can be rewritten, in analogy with (4) and (5), as

$$(9) \quad E_k(z) = \sum_{V \in G} f_k(Vz), \quad f_k(z) = z^{-k}.$$

Here, once again, the Eisenstein series $G_k(\tau)$ comes to mind, for defining

$$E_k^*(z; \omega_1, \omega_2) = E_k(z; \omega_1, \omega_2) - \frac{1}{z^k},$$

we have $E_k^*(0; \tau; 1) = G_k(\tau)$.

For $k = 2$ the nice convergence (absolute-uniform) on compact subsets of \mathbb{C} which do not contain any of the lattice points $m\omega_1 + n\omega_2$ of (9) fails, but this is well understood—this difficulty is inessential and can be overcome by subtraction of “convergence terms” from the summands:

$$(10) \quad E_2(z) = \frac{1}{z^2} + \sum'_{m, n \in \mathbb{Z}} \left\{ \frac{1}{(z + m\omega_1 + n\omega_2)^2} - \frac{1}{(m\omega_1 + n\omega_2)^2} \right\}$$

Here, \sum' has the same meaning as in (2).) "Nice" convergence of (10) follows readily, and $E_2(z)$ clearly has a pole of order 2 at each lattice point. However, in re-establishing convergence we apparently have sacrificed invariance with respect to $G(\omega_1, \omega_2)$. It appears, in fact, that invariance has given way to the characteristic functional equation of an elliptic integral:

$$(11) \quad E_2(Vz) = E_2(z) + C_V, V \in G(\omega_1, \omega_2),$$

where C_V is a constant dependent upon V . As it turns out, the sacrifice is only apparent, since $E_2(z)$ is an even function ($E_2(-z) = E_2(z)$) and this fact implies directly that $C_V = 0$ for all $V \in G$. Thus, $E_2(z)$ is a genuine elliptic function, not an elliptic integral. Of course, $E_2(z)$ is the well-known Weierstrass function $\wp(z)$ [7, §9].

4. Remarks on automorphic forms.

The modular invariant $J(\tau)$ was first studied by Dedekind and, independently, by Klein in 1877, about fifty years after the development of elliptic functions. Shortly thereafter, Picard used $J(\tau)$ and the monodromy theorem to prove his famous "little" theorem: an entire function omitting more than one complex value from its range is constant. Nowadays Picard's little theorem is most often proved using instead of $J(\tau)$ the related function $\lambda(\tau)$, invariant with respect to the principal congruence subgroup of level 2, a normal subgroup of index 6 in $\Gamma(1)$. ($\lambda(\tau)$ has a simple expression in terms of the Weierstrass elliptic functions $\wp(z)$ and $\wp'(z)$.) About the same time H. A. Schwarz and Poincaré used the theory of automorphic functions in studying ordinary second-order linear differential equations.

This was the context for Poincaré's fundamental work [28], which effectively initiated a systematic theory of automorphic forms and automorphic functions with respect to Fuchsian groups, discrete groups of linear fractional transformations acting on a half-plane or disc. In the background of Poincaré's work (and dominant in the contemporaneous work of Klein) is the idea of a Riemann surface. In light of the later "uniformization theorem," proved completely in 1912 after thirty years of effort by a number of mathematicians, the theory of Riemann surfaces can be viewed as contained in the theory of Fuchsian groups. The relationship between the two theories is close at hand: given a Fuchsian group Γ acting on a disc or half-plane D , one can introduce a natural topology on the set of orbits $S = \Gamma \backslash D$ in such a way that the structure is analytic, the topological space on S correspond to the automorphic functions with respect to Γ , the (first-order) differentials on S to the automorphic forms of weight 2 with respect to Γ .

The problem of uniformization deals with the converse: given an arbitrary Riemann surface, is there a pair

(Γ, D) as above, such that S is conformally equivalent to $\Gamma \backslash D$? The affirmative answer given by the uniformization theorem means that the theory of Fuchsian groups is co-extensive with the theory of Riemann surfaces. However, there does not seem to be a simple, natural interpretation of automorphic forms of arbitrary real weights on a Fuchsian group in terms of the corresponding Riemann surface.

For further details about the history of automorphic forms and their role in contemporary mathematics, I refer the reader to the Historical Development chapter (chapter 1) of [17] and to the references supplied there.

II. Rademacher's work on $J(\tau)$.

1. $J(\tau)$ as a parabolic Poincaré series.

The exact formula of Petersson and Rademacher for the coefficients c_n in the expansion (3) of $J(\tau)$ is

$$(12) \quad c_n = \frac{2\pi}{\sqrt{n}} \sum_{\ell=1}^{\infty} \ell^{-1} A_{\ell}(n) I_1 \left(\frac{4\pi\sqrt{n}}{\ell} \right), n \geq 1.$$

Here, $A_{\ell}(n)$ is a Kloosterman sum defined by

$$(13) \quad A_{\ell}(n) = \sum_{\substack{h, \text{mod } \ell \\ (h, \ell) = 1}} \exp \left[\frac{-2\pi i}{\ell} (nh + h') \right], hh' \equiv -1 \pmod{\ell},$$

while I_1 is the modified Bessel function of the first kind, given by the power series

$$(14) \quad I_1(x) = \sum_{j=0}^{\infty} \frac{(x/2)^{2j+1}}{j!(j+1)!}.$$

Rademacher obtains this formula in [30] by a refinement of his own variant [32] of the Hardy-Ramanujan "circle method" (in contrast to Petersson's entirely different approach involving modular forms of weight 2). In [31] he proves the following result, which brings to light a completely new way of viewing the fundamental modular invariant $J(\tau)$.

Theorem 1. [31, (4.1)]. $J(\tau)$ has the representation

$$(15) \quad 12^3 J(\tau) = e^{-2\pi i \tau} + e^{2\pi i / \tau} + 731 + \lim_{K \rightarrow \infty} \sum_{\ell=1}^K \sum_{\substack{1 \leq |m| \leq K \\ (\ell, m) = 1}} \left\{ \exp \left(-2\pi i \frac{m' \tau + \ell'}{\ell \tau - m} \right) - \exp(-2\pi i m' / \ell) \right\},$$

where m' is any integral solution of the congruence $mm' \equiv -1 \pmod{\ell}$ and ℓ' is the rational integer defined by $-\ell' = (mm' + 1)/\ell$.

In the historical introduction to his influential work, *Discontinuous groups and automorphic functions*, J. Lehner

has expressed the opinion that this formula for $J(\tau)$ "is as striking and elegant as the classic identities of Euler and Jacobi". [17, p. 41] Lehner further refers to the formula (15) as "an expansion of J into partial fractions," and he compares it with the definition (10) of the Weierstrass function \wp , noting in particular, "the subtracted 'convergence summand' in each case" [17, pp. 40-41]. To appreciate more fully the insight which informs this remark, we rewrite (15) to resemble closely a modified form of the Poincaré series (5), namely, the "parabolic Poincaré series" introduced by Petersson [24]:

$$(16) \quad G_k(\tau; \nu) = \sum^* \frac{e^{2\pi i \nu V \tau / \lambda}}{(c\tau + d)^k}.$$

Here, ν is an arbitrary integer, k is an integer, $\lambda > 0$ is the minimal width of a translation in Γ (e.g., $\lambda = 1$ for $\Gamma = \Gamma(1)$) and the notation \sum^* indicates that—in contrast to the summation over all $V \in \Gamma$ as in (5)—in (16) the sum is confined to $V \in \Gamma$ with distinct lower row c, d . This restriction arises naturally as a necessary condition for convergence since the rational function f of (5) has given way in (16) to the exponential function $e^{2\pi i \nu V \tau / \lambda}$. For, the periodicity of $e^{2\pi i \nu V \tau / \lambda}$ implies that the numerator $e^{2\pi i \nu V \tau / \lambda}$ in (16) is independent of the upper row of V , and from this it follows directly that, regardless of the size of k , the full sum on all $V \in \Gamma$ cannot converge, since each summand would then occur infinitely often. On the other hand, the assumption $k > 2$ assures absolute uniform convergence of the series in (16) on compact subsets of \mathcal{H} [17, pp. 276-277].

As with the Poincaré series (5), Petersson's modified Poincaré series (16) are automorphic forms of weight k on Γ as long as k is an integer greater than two. The proof is the same in both cases. The parabolic Poincaré series have two clear advantages over the Poincaré series (5): (i) the analytic behavior of $G_k(\tau; \nu)$ can be controlled completely at the parabolic cusps of Γ ; (ii) the $G_k(\tau; \nu)$ behave well with respect to the Petersson inner product, well enough, indeed, to make possible a direct inference that they form a basis for all automorphic forms of weight k on Γ which are holomorphic in \mathcal{H} and at the finite cusps [17, pp. 284-289].

To compare the expression (15) with the parabolic Poincaré series (16) we begin by recalling that the full modular group $\Gamma(1)$ is the group of invariance for $J(\tau)$. Furthermore, $c\tau + d$ occurs as the lower row of a transformation in $\Gamma(1)$ precisely when c and d are relatively prime integers. With a simple change of notation the double sum in (15) becomes

$$(17) \quad \sum_{1 \leq c \leq K} \sum_{\substack{1 \leq |d| \leq K \\ (c,d)=1}} \left\{ \exp \left(-2\pi i \frac{a\tau + b}{c\tau + d} \right) - \exp(-2\pi i a/c) \right\},$$

where a and b are so chosen that $V_{c,d} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \in \Gamma(1)$. We next take advantage of the fact that the summands in (17) are unchanged under replacement of the pair (c, d) by the pair $(-c, -d)$, to rewrite the sum (17) as

$$\frac{1}{2} \sum_{1 \leq |c| \leq K} \sum_{\substack{1 \leq |d| \leq K \\ (c,d)=1}} \{ \exp(-2\pi i V_{c,d} \tau) - \exp(-2\pi i a/c) \}.$$

But, the condition $(c, d) = 1$ implies that $c = 0$ occurs only with $d = \pm 1$, and $d = 0$ only with $c = \pm 1$. In the former case we can choose the matrices to be $\pm \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ and in the latter, $\pm \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$. Thus, with the definition

$$s(c, d) = \begin{cases} e^{-2\pi i a/c} & c \neq 0 \\ 0, & c = 0, \end{cases}$$

the expression (15) becomes

$$(18) \quad 12^3 J(\tau) = 732 + \lim_{K \rightarrow \infty} \frac{1}{2} \sum_{|c| \leq K} \sum_{\substack{|d| \leq K \\ (c,d)=1}} \{ \exp(-2\pi i V_{c,d} \tau) - s(c, d) \}.$$

Comparison of (18) with (16) now clearly justifies our viewing the right-hand side of (18) as a parabolic Poincaré series of weight $k = 0$ on the group $\Gamma(1)$, for $\nu = -1$, but with the order of summation prescribed explicitly (lattice points in expanding squares) and modified by the subtracted convergence summands $s(c, d)$. We stress that without this prescription and modification, there can be no hope of convergence for a Poincaré series of weight $k = 0$. (For $\Gamma(1)$ absolute convergence occurs only for $k > 2$.) Even with them, convergence remains far from obvious. The proof comes naturally out of Rademacher's development.

2. Invariance of $J(\tau)$.

As we remarked earlier in reference to the definition (10) of $\wp(z)$ ($= E_2(z)$), modification by the convergence summands $s(c, d)$ seems to disturb the invariance under $\Gamma(1)$ of the right-hand side of (18), leading to the introduction of additive periods in the transformation formulae (as in (11)). At first glance, then, Rademacher's formula (18) appears to imply only that $J(\tau)$ is an abelian integral with respect to $\Gamma(1)$, but not necessarily a modular invariant (i.e. that the periods vanish). But, in the case of $\wp(z)$, invariance does follow quite directly from the structure of the formula (18).

To see this, recall that invariance under all of $\Gamma(1)$ will result from the single transformation formula $J(-1/\tau) = J(\tau)$. We note from (18) that to prove this it will suffice to demonstrate the invariance under $\tau \rightarrow -1/\tau$ of the finite sum

$$\sum_K(\tau) = \sum_{|c| \leq K} \sum_{\substack{|d| \leq K \\ (c,d)=1}} \exp(-2\pi i V_{c,d} \tau).$$

However,

$$\sum_K (-1/\tau) = \sum_{|c| \leq K} \sum_{\substack{|d| \leq K \\ (c,d)=1}} \exp\{-2\pi i V_{c,d}(-1/\tau)\} \\ = \sum_{|c| \leq K} \sum_{\substack{|d| \leq K \\ (c,d)=1}} \exp(-2\pi i V_{d,-c}\tau),$$

$$\text{since } \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} = \begin{pmatrix} b & -a \\ d & -c \end{pmatrix} = V_{d,-c}.$$

Now we infer $\sum_K (-1/\tau) = \sum_K (\tau)$ by matching the pair (c, d) with the pair $(d, -c)$.

3. Sketch of the proof of Theorem 1.

We present a very brief account of Rademacher's derivation of the expression (15) from the definition of $J(\tau)$ given by (3) and (12). At the heart of the method is a difficult technical lemma justifying rearrangement of a certain conditionally convergent double series.

Rademacher begins by inserting the expressions (12) and (13) into (3), and then inverting the order of summation in the double sum so obtained. The validity of this step relies crucially upon the estimate of Weil [36],

$$A_\ell(n) = O(\ell^{1/2+\epsilon}), \epsilon > 0,$$

uniformly in n . (Actually, any nontrivial estimate $A_\ell(n) = O(\ell^{1-\delta})$, $\delta > 0$, would suffice for the purpose.) The interchange of summations implies that $12^3 J(\tau)$, as defined by (3) and (12), equals

$$e^{-2\pi i \tau} + 744 + 2\pi \sum_{\ell=1}^{\infty} \frac{1}{\ell} \sum_{h(\text{mod } \ell)} e^{-2\pi i h/\ell} \\ \times \sum_{n=1}^{\infty} \exp[2\pi i n(\tau - h/\ell)] \frac{1}{\sqrt{n}} I_1\left(\frac{4\pi\sqrt{n}}{\ell}\right).$$

Next, he replaces I_1 by the power series (14), performs another interchange of summations and—in the salient feature of his calculation—makes use of the Lipschitz sum formula [12, p. 65],

$$\sum_{n=1}^{\infty} n^p e^{2\pi i n \tau} \\ = \begin{cases} -\frac{1}{2} + \frac{1}{2\pi} \lim_{N \rightarrow \infty} \sum_{q=-N}^N (-i\tau + iq)^{-1}, & p = 0 \\ \frac{p!}{(2\pi)^{p+1}} \sum_{q=-\infty}^{\infty} (-i\tau + iq)^{-p-1}, & p \in \mathbb{Z}^+. \end{cases}$$

This transforms (19) into

$$e^{-2\pi i \tau} + 732 \\ + \sum_{\ell=1}^{\infty} \lim_{N \rightarrow \infty} \sum_{\substack{|m| \leq N \\ (m,\ell)=1}} e^{-2\pi i m/\ell} \sum_{p=1}^{\infty} \frac{1}{p!} \left\{ \frac{2\pi i}{\ell(\ell\tau - m)} \right\}^p.$$

At this point Rademacher divides the multiple sum in (21) into the two parts

$$\sum_{\ell=1}^{\infty} \lim_{N \rightarrow \infty} \sum_{\substack{|m| \leq N \\ (m,\ell)=1}} e^{-2\pi i m/\ell} \left\{ \frac{2\pi i}{\ell(\ell\tau - m)} \right\} \\ + \sum_{\ell=1}^{\infty} \lim_{N \rightarrow \infty} \sum_{\substack{|m| \leq N \\ (m,\ell)=1}} e^{-2\pi i m/\ell} \sum_{p=2}^{\infty} \frac{1}{p!} \left\{ \frac{2\pi i}{\ell(\ell\tau - m)} \right\}^p,$$

a step justified on the grounds that the second is absolutely convergent as a triple sum and first is convergent by virtue of its appearance as the left-hand side in

Rademacher's Lemma. [31, p. 238, (2.1)]. Suppose $\tau \in \mathcal{H}$. Then,

$$(22) \quad \sum_{\ell=1}^{\infty} \lim_{N \rightarrow \infty} \sum_{\substack{|m| \leq N \\ (m,\ell)=1}} \left\{ \frac{\exp(-2\pi i m/\ell)}{\ell(\ell\tau - m)} \right\} \\ = \lim_{K \rightarrow \infty} \sum_{\ell=1}^K \sum_{\substack{|m| \leq K \\ (m,\ell)=1}} \{ \},$$

with m' defined as in the statement of Theorem 1. (Convergence of the right-hand side of (22) implies directly the convergence of (18), the (modified) parabolic Poincaré series of weight $k = 0$.)

Applying the Lemma to the first sum and absolute convergence to the second, he obtains

$$(23) \quad 12^3 J(\tau) = e^{-2\pi i \tau} + 732 + \lim_{K \rightarrow \infty} \sum_{\ell=1}^K \sum_{\substack{|m| \leq K \\ (m,\ell)=1}} \\ e^{-2\pi i m'/\ell} \sum_{p=1}^{\infty} \frac{1}{p!} \left\{ \frac{2\pi i}{\ell(\ell\tau - m)} \right\}^p \\ = e^{-2\pi i \tau} + 732 + \lim_{K \rightarrow \infty} \sum_{\ell=1}^K \sum_{\substack{|m| \leq K \\ (m,\ell)=1}} \\ e^{-2\pi i m'/\ell} \left\{ \exp\left(\frac{2\pi i}{\ell(\ell\tau - m)}\right) - 1 \right\}.$$

Finally, (15) results from (23) upon separation of the single term for $m = 0$ (with $\ell = 1$), and application of the simple identity

$$-m'/\ell + \frac{1}{\ell(\ell\tau - m)} = \frac{-m'\tau - \ell'}{\ell\tau - m}$$

(m', ℓ' defined as in the statement of Theorem 1) and the invariance of the summand under the map $(\ell, m) \rightarrow (-\ell, -m)$.

III. Connection with Eichler cohomology.

1. Generalization to modular forms of nonpositive weight.

A number of mathematicians have developed Rademacher's ideas further, extending them (i) to discrete groups of real linear fractional transformations other than $\Gamma(1)$; (ii) to automorphic forms of weights $k \leq 0$. (See §1.2, following (7), for the definition.) Here we emphasize the generalization to forms of negative weight, as this leads directly to the Eichler cohomology theory.

We confine our attention to the case of automorphic forms F on $\Gamma(1)$ (that is, *modular forms*) of weight $k \leq 0$, with k an even integer and with "multiplier system" identically one. This means F satisfies (7), with k even and ≤ 0 , for all $M \in \Gamma(1)$. (For a definition and discussion of multiplier systems, see [12, pp. 12–13] or [17, pp. 267–268].) The definition of modular form requires, as well, that F be holomorphic in \mathcal{H} and expressible there as an exponential series of the form

$$(24) \quad F(\tau) = \sum_{n=-\mu}^{\infty} a_n e^{2\pi i n \tau}.$$

(Note that periodicity of F follows from (7), with $M = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$.)

Rademacher derived the exact formula (12) for the coefficients in the expansion of $J(\tau)$ by refining a method he and Zuckerman [32] had devised earlier to calculate the coefficients a_n in the exponential series (24) for an arbitrary modular form F of negative weight k ("positive dimension"— k in the terminology of [32]). The formula of Rademacher and Zuckerman for the a_n , in the special case when k is even (and the multiplier system is identically one), is

$$(25) \quad a_n = (-1)^{k/2} (2\pi) \sum_{\nu=1}^{\mu} a_{-\nu} \sum_{\ell=1}^{\infty} \ell^{-1} A_{\ell, \nu}(n) (\nu/n)^{(-k+1)/2} I_{-k+1} \left\{ \frac{4\pi}{\ell} \sqrt{n\nu} \right\}, \quad n \geq 1,$$

where

$$(26) \quad A_{\ell, \nu}(n) = \sum_{\substack{h \pmod{\ell} \\ (h, \ell) = 1}} \exp \left[\frac{-2\pi i}{\ell} (nh + \nu h') \right], \quad hh' \equiv -1 \pmod{\ell},$$

and

$$(27) \quad I_{-k+1}(x) = \sum_{j=0}^{\infty} \frac{(x/2)^{2j-k+1}}{j!(j-k+1)!}.$$

Remarks. 1. The expression (25) implies that a modular form of weight $k < 0$ which is bounded at $i\infty$ (that is, $a_{-1} = a_{-2} = \dots = a_{-\mu} = 0$ in (24)) is identically zero.

This can be proved for $k \leq 0$ without invoking (25) [11, pp. 24–30] or [17, pp. 166–176].

2. When $k = 0$, $\mu = 1$ and $a_{-1} = 1$, then (25) reduces to the series (12) for the coefficient of $J(\tau)$.

3. Both Lehner [19, 20] and Petersson [23] have derived (25) in the broader setting in which a general H -group Γ [17, p. 266] replaces $\Gamma(1)$. In this more general case, the structure of the series for a_n remains unchanged in its essentials.

The Rademacher-Zuckerman formula (25) makes available in the wider context of modular forms with weights $k \leq 0$ precisely the same viewpoint that Rademacher adopts in [31] toward $J(\tau)$. Specifically, one can define the function $F(\tau)$ by the series (24) and (25) and ask—as Rademacher did concerning $J(\tau)$ —how (or more tentatively, whether) it is possible to show from this definition that $F(\tau)$ does in fact satisfy (7), the characteristic functional equation for a modular form of weight k . This perspective, indeed, forms the basis for much of the work I undertook in the early 1960's [8, 9, 10, 11, 13, 14]. As it turns out, it is impossible to show that all functions $F(\tau)$ so defined are modular forms, not because of a defect in the method, but rather because they are not all modular forms. We shall comment upon this further in §III.2, below.

Rademacher's method yields:

Theorem 2. [11, p. 28, (3.07)]. For $\tau \in \mathcal{H}$ define the function

$$F_{\nu}(\tau) = e^{-2\pi i \nu \tau} + (-1)^{k/2} (2\pi) \sum_{n=1}^{\infty} a_n(\nu) e^{2\pi i n \tau},$$

with ν a positive integer and $a_n(\nu)$ the infinite sum of ℓ occurring in (25). Put $r = -k$, a positive even integer. Then, $F_{\nu}(\tau)$ is holomorphic in \mathcal{H} and it has the representation

$$(28) \quad F_{\nu}(\tau) = e^{-2\pi i \nu \tau} + \alpha_{\nu} + \tau^r \left\{ \exp(2\pi i \nu / \tau) - \sum_{t=0}^r \frac{1}{t!} (2\pi i \nu / \tau)^t \right. \\ \left. + \lim_{K \rightarrow \infty} \sum_{\ell=1}^K \sum_{1 \leq |m| \leq K} (\ell \tau - m)^r \left\{ \exp \left(-2\pi i \nu \frac{m' \tau + \ell'}{\ell \tau - m} \right) - \exp(-2\pi i m' \nu / \ell) \sum_{t=0}^r \frac{1}{t!} \left(\frac{2\pi i \nu}{\ell(\ell \tau - m)} \right)^t \right\} \right\}$$

where α_{ν} is a constant depending only upon ν and r [11, p. 27], where α_{ν} is denoted c_{ν} .

The proof of (28) requires that a generalization of the Rademacher Lemma in which

$\ell^{1-k}(\ell\tau - m)$ replaces the denominator $\ell(\ell\tau - m)$ of (19). The analogy of (28) with (15) needs no clarification; when $\nu = 1$ and $k = 0$ (so $r = 0$), (28) reduces to (15). Like the expression (15) for $J(\tau)$, (28) can be rewritten as a modified parabolic Poincaré series of weight $k < 0$ on $\Gamma(1)$, comparable to (18):

$$(29) \quad F_\nu(\tau) - \alpha_\nu = \lim_{K \rightarrow \infty} \sum_{|c| \leq K} \sum_{\substack{|d| \leq K \\ (c,d)=1}} \{(\gamma\tau + d)^r \exp(-2\pi i \nu V_{c,d} \tau) - q(\tau; c, d)\},$$

where $q(\tau; c, d)$ is the polynomial of degree $r = -k$ given by

$$(30) \quad q(\tau; c, d) = \begin{cases} e^{-2\pi i \nu / c} \sum_{t=0}^r \frac{1}{t!} \left(\frac{2\pi i \nu}{c}\right)^t (\gamma\tau + d)^{r-t}, & c \neq 0, \\ 0, & c = 0. \end{cases}$$

The "convergence terms" $q(\tau; c, d)$ here replace the $s(c, d)$ appearing in (18); when $\nu = 1$ and $k = 0$, $q(\tau; c, d)$ reduces to $s(c, d)$.

2. The Eichler cohomology theorem.

Since $F_\nu(\tau + 1) = F_\nu(\tau)$ follows directly from the definition of F_ν (without regard to the nature of the $a_n(\nu)$), showing that $F_\nu(\tau)$ is a modular form of weight k on $\Gamma(1)$ reduces to proving the single transformation formula

$$(31) \quad \tau^{-k} F_\nu(-1/\tau) = F_\nu(\tau).$$

However, the presence of the subtracted polynomials $q(\tau; c, d)$ in (29) gives rise instead to a transformation formula of a more general kind, namely,

$$(32) \quad \tau^{-k} F_\nu(-1/\tau) = F_\nu(\tau) + p_\nu(\tau),$$

with $p_\nu(\tau)$ a polynomial "period" of degree $\leq r = -k$. In contrast to the case of $J(\tau)$ ($k = 0$ and $\nu = 1$), when $k < 0$ these polynomial periods do not always disappear. In fact, the identical vanishing of $p_\nu(\tau)$ depends upon the parameters k and ν , and in the generic situation $p_\nu(\tau)$ does not vanish. This, notwithstanding the fact that $p_\nu(\tau) \equiv 0$ for all $\nu \in \mathbb{Z}^+$ when $k = 0, -2, -4, -6, -8$ and -12 . Conspicuously, $k = 10$ does not belong on this list. (Verification of these facts is left aside.) Thus, while the exact formula (25) of Rademacher-Zuckerman shows that every modular form of weight $k < 0$ is a linear combination of the functions $F_\nu(\tau)$, the converse is not true (at least for $k = -10$ and even $k \leq -14$). Of course, with fixed k one can form a linear combination of sufficiently many $F_\nu(\tau)$ to force the disappearance of the additive polynomial and thus obtain a modular form. There are stringent conditions upon such linear combinations, explained by Petersson through his "principal

parts condition" [23, Theorems 1 and 3] and his "gap theorem" for automorphic forms [26, Theorem 1].

This state of affairs has made inevitable the frequent, prominent appearance of functions having transformation laws like (32) - that is, with additive polynomials - observable in the recent (since (1957)) study of modular and automorphic forms. These "Eichler integrals" - as they are called - are functions $F(\tau)$ holomorphic in \mathcal{H} and satisfying

$$(33) \quad (\gamma\tau + \delta)^{-k} F(M\tau) = F(\tau) + p_M(\tau),$$

for all $M = \begin{pmatrix} \alpha & \beta \\ \gamma & \delta \end{pmatrix} \in \Gamma$, a discrete group of real linear fractional transformations. Here, k is an even integer ≤ 0 , called the *weight* of the integral $F(\tau)$, and $p_M(\tau)$ is a polynomial in τ of degree at most $-k$. The $p_M(\tau)$ are the *period polynomials* of $F(\tau)$. Combining (32) and the fact that $F_\nu(\tau + 1) = F_\nu(\tau)$, we find that the functions $F_\nu(\tau)$ are Eichler integrals on $\Gamma(1)$, since $\tau \rightarrow \tau + 1$ and $\tau \rightarrow -1/\tau$ generate the group. Naturally, if $p_M(\tau) \equiv 0$ for all $M \in \Gamma$ in (33), then the Eichler integral F is really an automorphic form on Γ .

Of crucial importance in establishing a further non-trivial link between Eichler integrals and automorphic forms is the differentiation formula of G. Bol [2],

$$(34) \quad D^{(-k+1)}\{(\gamma\tau + \delta)^{-k} F(M\tau)\} = (\gamma\tau + \delta)^{k-2} F^{(-k+1)}(M\tau),$$

where $M = \begin{pmatrix} \alpha & \beta \\ \gamma & \delta \end{pmatrix}$, with $\alpha\delta - \beta\gamma = 1$. Clearly, (34) implies that the $(-k+1)^{\text{st}}$ derivative of an Eichler integral of weight k on Γ is an automorphic form on Γ of weight $2 - k$. (34) follows for differentiable F by induction on $-k$ and for analytic F by the Cauchy integral formula.

An immediate consequence of (33) is the (cocycle) consistency condition

$$(35) \quad p_{M_1 M_2} = p_{M_1}|M_2 + p_{M_2}, \text{ for all } M_1, M_2 \in \Gamma,$$

where for convenience we have introduced the *slash operator*

$$(\phi|M)(\tau) = (\gamma\tau + \delta)^{-k} \phi(M\tau),$$

for $M = \begin{pmatrix} \alpha & \beta \\ \gamma & \delta \end{pmatrix}$. When ϕ is a polynomial of degree $\leq -k$, so is $\phi|M$. A collection of polynomials $\{p_M|M \in \Gamma\}$ satisfying (35) - thus, necessarily of degree $\leq -k$ - forms a (weight $-k$) *cocycle* on Γ . Given a fixed polynomial p of degree $\leq -k$ it generates the cocycle $\{p_M|M \in \Gamma\}$ by means of $p_M = p|M - p$. We call a cocycle of this special form a *coboundary* and define the *Eichler cohomology group* $H_{-k}^1(\Gamma)$ as the quotient vector space of weight $-k$ cocycles modulo weight $-k$ coboundaries.

The identity (34) suggests a direct relationship between $H_{-k}^1(\Gamma)$ and automorphic forms of weight $2 - k$ on Γ , which we can establish as follows. Let G be such a form and F a $(-k+1)$ -fold anti-derivative of G . Then

by (34) F satisfies (33), with $p_M(\tau)$ a polynomial of degree $\leq -k$ for each $M \in \Gamma$. This produces a mapping into $H_{-k}^1(\Gamma)$, if we attach to G the cohomology class in $H_{-k}^1(\Gamma)$ of the cocycle $\{p_M | M \in \Gamma\}$. Indeed, Eichler's classic paper [3], which initiated the study of $H_{-k}^1(\Gamma)$, identifies a distinguished subspace of $H_{-k}^1(\Gamma)$ with a direct sum of two spaces of automorphic forms of weight $2 - k$ on Γ :

Eichler Cohomology Theorem. For $k \in \mathbb{Z}, k \leq 0$, $H_{-k}^1(\Gamma)$ is isomorphic to the direct sum $C^+(\Gamma, 2 - k) \oplus C^0(\Gamma, 2 - k)$, provided Γ is an H -group [17, p. 266].

Remarks 1. $C^+(\Gamma, 2 - k)$ is the (finite-dimensional) space of *entire* automorphic forms on Γ of weight $2 - k$, those forms for which at each parabolic cusp of Γ the exponential expansion has no terms with negative exponents. $C^0(\Gamma, 2 - k)$ is the subspace of *cusp forms* in $C^+(\Gamma, 2 - k)$, those entire forms such that each expansion contains only terms with positive exponents.

2. For simplicity I have stated only a restricted form of the version of Eichler's theorem given in [6]. However, this form of the theorem exhibits the essence of the full result. Other versions include Eichler's original result [3] and [34, 4, 16, 18, 15].

The proof of the Eichler theorem given in [6] depends strongly upon Theorem 2, extended to general H -groups Γ . This generalization applies directly to establish a strong connection between the cocycle $\{p_M\}$ arising from F_ν and the cocycle $\{p_M^*\}$ arising from $F_{-\nu}$ (the result of replacing ν by $-\nu$ in the Fourier series definition of F_ν):

$$(36) \quad p_M^*(\tau) = \overline{p_M(\bar{\tau})}.$$

(See [10, (4.8)].) Then, for a linear mapping suitably defined from automorphic forms of weight $2 - k$ into $H_{-k}^1(\Gamma)$, the relation (36) yields a proof that the mapping is one-to-one [6, pp. 570–571]. (This mapping necessarily keeps C^+ and C^0 disjoint, even though $C^0 \subset C^+$.) The proof that the range of this mapping consists of the entire space $H_{-k}^1(\Gamma)$ requires Petersson's generalized Riemann-Roch Theorem [27, Theorem 9].

The Eichler cohomology theorem may be regarded as stating that *every polynomial cocycle arises as the system of period polynomials of some Eichler integral*, and that *this Eichler integral is uniquely determined by the cohomology class of the given cocycle*. Like the Riemann-Roch theorem (more properly, Petersson's generalization of it), the Eichler cohomology theorem establishes a profound connection - only hinted at by (34) - between automorphic forms of weight $2 - k$ ($k \in \mathbb{Z}, k \leq 0$) and those of weight k . It shows that each entire automorphic form of weight $2 - k$ gives rise to an "obstruction" to the existence of forms of weight k , and that each cusp form in fact gives rise to two such obstructions.

IV. Concluding Remarks

Although appearing eighteen years after [31], Eichler's work did not find its motivation in Rademacher's approach to $J(\tau)$. This is clear both from the internal evidence (Eichler's article itself) and from the fact that the necessary link is established not in Rademacher's work, but in the extensions of it to negative weight in [8, 10, 11], published between 1960 and 1962. Thus one can consider Eichler cohomology an outgrowth of Rademacher's work on $J(\tau)$ is an instance of hindsight, an example illustrating the familiar, yet striking, fact that developments which seem unrelated at first can turn out with time to be aspects of the same mathematical phenomenon.

I have not described all of the applications now in the literature of Rademacher's method. These include: (i) the use of the method to construct Poincaré series of weight 2 (in which case convergence problems arise in the definition (16)) [21, 35]; (ii) application to the construction of automorphic forms of real (not necessarily integral) nonpositive weights [22]. In [21] Lehner restricted his attention to Poincaré series of weight 2 on $\Gamma(1)$, while Smart [35] carried out a generalization to certain subgroups of finite index in $\Gamma(1)$. The work of Niebur [22], while significant principally for its extension of Rademacher's method to nonintegral weights, provides new insights even for negative integral weight when the weight is an integer the results of [22] do not reduce to those of [10], but strengthen them instead.

According to Paul Bateman, Rademacher tried without success to extend his method of [31] to nonintegral weights, in particular to the function $1/\eta(\tau)$, which has weight $-1/2$. We may therefore safely assume that, could he have known of it, Rademacher would have been most interested in Niebur's work. In the spring of 1963, well before that work was begun, I had the opportunity to tell Professor Rademacher about my own generalization to negative integral weights. As we walked alone, near the university campus in Madison, Wisconsin, I broached the subject and he seized upon it with apparent interest. But, within moments, something distracted us; to my later regret, we never returned to the subject.

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The series of Special Articles was created to provide a place for articles on mathematical subjects of interest to the general membership of the Society. The Editorial Committee of the *Notices* is especially interested in the quality of exposition and intends to maintain the highest standards in order to assure that the Special Articles will be accessible to mathematicians in all fields. The articles must be interesting and mathematically sound. They are first refereed for accuracy and (if approved) accepted or rejected on the basis of the breadth of their appeal to the general mathematical public.

Items for this series are solicited and, if accepted, will be paid for at the rate of \$250 per page up to a maximum of \$750. Manuscripts to be considered for this series should be sent to Ronald L. Graham or Jeffrey C. Lagarias, Associate Editors for Special Articles, *Notices of the American Mathematical Society*, Post Office Box 6248, Providence, Rhode Island 02940.

The National Science Foundation Budget Request for Fiscal Year 1991

This article is the 18th in an annual series of reports outlining the President's request to Congress for the NSF budget. Last year's report appeared in the April 1989 issue of *Notices*, page 359.

It's that time of the year again when the Executive Branch presents its budgetary wish list to Congress. Included is the budget request for the National Science Foundation (NSF) for fiscal year 1991, which begins in October, 1990. Well-respected for funding solid research, the NSF holds a unique place among science agencies. But in the last few years, that special position has meant that the NSF has been asked to take responsibility for an increasing number of tasks with only modest budgetary increases. Mathematics and science education, academic research, developing stronger ties between universities and industry, academic facilities modernization—can a relatively small government agency do all this?

Congress and the Administration both enthusiastically support the NSF but seem to be at odds over its role. The typical pattern of recent years has the President requesting double-digit increases for the Foundation, with healthy hikes for research. Then Congress, under severe strain to reduce the deficit, shaves percentages off the increase and asserts its own priorities by shifting funds to NSF's education directorate. And in FY 1990, over the opposition of the NSF and the Administration, Congress instructed the Foundation to fund modernization of academic research facilities.

The FY 1990 Budget

Formulation of the NSF budget request begins with negotiations between the NSF and the Office of Management and Budget, which tries to translate the Administration's priorities into budget numbers for the departments and agencies of the federal government. The resulting budget request is sent to both houses of Congress, each of which reworks the budget to its liking. The NSF budget is overseen by the House and Senate Committees for Veteran's Administration, Housing and Urban Development,

and Independent Agencies. This committee assignment makes for some particularly difficult choices, for the NSF must compete for increases with such programs as Veterans Medical Care and Assisted Housing.

Little of the requested increase for FY 1990 actually materialized. Across-the-board reductions sawed off a couple of favorite perches from which NSF advocates have crowed about doubling the NSF budget. For one thing, no new awards in the much-publicized Science and Technology Centers (STC) program will be made in FY 1990, though the NSF intends to use FY 1991 money to fund some new centers out of the current batch of proposals. The reductions also meant a scaling back of the increases intended to offset inflation on continuing grants, a measure that frustrates NSF Director Eric Bloch's efforts to increase average grant size.

Originally, the President's requested increase for the NSF's FY 1990 budget was about 14%, with a sizeable 15.5% increase for the Division of Mathematical Sciences (DMS). The House and Senate compromised on a 12% increase, but Gramm-Rudman-Hollings automatic reductions, as well as an across-the-board reduction to finance the "war on drugs," whittled it down to 8.5%. With its 5% increase, the DMS did better than the other MPS divisions. The Mathematical and Physical Sciences (MPS) directorate, the larger organizational structure containing the DMS. Other MPS divisions fared even worse: for example, the Physics Division received a 1% increase, a substantial loss after inflation.*

Congress also instructed the NSF to spend \$20 million on the research facilities modernization program, despite NSF protests that the program is a luxury in a time of tight budgets. Everyone agrees that university labs and research facilities need reconstruction, modernization and expansion; everyone also agrees that \$20 million won't make a dent in solving the problem, which will run into billions of dollars to solve.

*These percentages were calculated by omitting \$75 million marked for reconstruction of the collapsed Green Bank telescope; therefore may not agree with analogous percentages calculated in the accompanying tables.

Table I. National Science Foundation

	1987 Actual	Change	1988 Actual	Change	1989 Actual	Change	1990 Plan	Change	1991 Request
(1) Mathematical Sciences Research Support	\$59.9	6.5%	\$63.8	3.4%	\$66.0	4.7%	\$69.1	6.7%	\$73.7
(2) Other Research Support (Note A)	1390.3	3.2%	1434.7	6.8%	1532.5	9.9%	1684.3	12.5%	1895.2
(3) Education, Foreign Currency Program (Note B)	99.6	40.2%	139.6	22.6%	171.1	19.4%	204.3	22.9%	251.0
(4) Program Development and Management ("Overhead") (Note C)	77.8	8.6%	84.5	8.0%	91.3	8.4%	99.0	12.1%	111.0
(5) Science and Technology Centers	—	—	—	—	25.0	8.0%	27.0	93.0%	52.1
(6) Totals	\$1627.6	5.8%	\$1722.6	9.5%	\$1885.9	10.5%	\$2083.6	14.4%	\$2383.0
(7) (1) as % of (1) and (2)	4.13%		4.26%		4.13%		3.94%		3.74%
(8) (1) as % of (6)	3.68%		3.70%		3.50%		3.32%		3.09%

Note A. Scientific research facilities (excluding mathematics), including national and special research programs and certain national research centers.

Note B. The programs provide support in every field, including mathematics. The foreign currency program was eliminated in FY 1989.

Note C. Administrative expenses of operating the Foundation. These funds are not considered to directly support research. Also included is the cost of the Office of the Inspector General.

Table II. Directorate of Mathematical and Physical Sciences

Division	1987 Actual	1988 Actual	1989 Actual	1990 Plan	1991 Request
Mathematical Sciences	\$59.9 (12.9%)	\$63.8 (13.5%)	\$66.0 (13.1%)	\$69.1 (12.4%)	\$73.7 (11.9%)
Astronomical Sciences	85.1 (18.3%)	85.8 (18.2%)	89.2 (17.7%)	91.7 (16.5%)	100.7 (16.2%)
Physics	117.0 (25.2%)	117.9 (25.0%)	122.3 (24.3%)	123.8 (22.2%)	130.2 (21.0%)
Chemistry	93.8 (20.2%)	94.0 (19.9%)	96.8 (19.2%)	98.0 (17.6%)	103.4 (16.6%)
Materials Research	108.9 (23.4%)	110.6 (23.4%)	115.1 (22.9%)	116.9 (21.0%)	123.5 (19.9%)
Science and Technology Centers	—	—	14.0 (2.8%)	14.5 (2.6%)	27.0 (4.3%)
Major Research Equipment (See Note)	—	—	0.5 (0.0%)	43.0 (7.7%)	63.0 (10.1%)
Totals	\$464.7	\$472.0	\$503.8	\$557.0	\$621.5

Note. This new budgetary heading includes a number of large-scale instrumentation projects, such as a gravitational wave observatory. A special Congressional appropriation of \$75 million was made last year to reconstruct the Green Bank telescope, which collapsed in 1988. Half of the \$75 million was carried over to FY 1990 from the FY 1989 budget and is therefore excluded from these figures.

Table III. Compilation of the NSF Budget, 1986-1991

	1986 Actual	1987 Actual	1988 Actual	1989 Actual	1990 Plan	1991 Request	Increase 1986-1989	Increase 1986-1991
(1) Mathematical Sciences Research Support	\$51.9	\$59.9	\$63.8	\$66.0	\$69.1	\$73.7	27.2%	42.0%
(2) Other Research Support	51.8	58.3	59.7	58.8	1684.3	1895.2	13.5%	47.6%
(3) Education, Foreign Currency Program	1283.8	1390.3	1434.7	1532.5	204.3	251.0	19.4%	6.6%
(4) Program Development and Management ("Overhead")	1281.2	1352.4	1342.2	1365.9			99.7%	192.9%
(5) Science and Technology Centers	85.7	99.6	139.6	171.1	204.3	251.0	78.4%	
(6) Totals	85.5	97.0	130.6	152.5			27.2%	54.6%
(7) (1) as % of (1) and (2)	71.8	77.8	84.5	91.3	99.0	111.0	13.5%	
(8) (1) as % of (6)	71.7	75.7	79.1	81.4	27.0	52.1	—	—
(9) Totals	—	—	—	25.0	27.0	52.1	—	—
(10) Totals	—	—	—	22.3				
(11) 1982 dollars	1493.2	1627.6	1722.6	1885.9	2083.6	2383.0	26.3%	59.6%
(12) Current dollars	1490.2	1583.3	1611.5	1680.9			12.8%	

*Current dollars are converted to 1982 dollars using the wholesale/producer index.

R&D Increases

In the federal government research and development picture as a whole, the NSF is small-fry: its projected budget of \$2.38 billion is only about 3.5% of the amount requested for R&D overall. "Big science" projects feature prominently in the federal R&D budget, and some rival the NSF budget in size. For example, the Administration has requested increases for the Strategic Defense Initiative (\$4.66 billion, up 22%) and the space station (\$2.63 billion, up 36%). The basic research category of the federal budget is to rise by 8%, compared to a requested 12% increase for NSF's research activities.

Among the Foundation's major areas of increase for FY 1991 is the Computer and Information Science and Engineering directorate, set to rise by \$23.6 million (13.8%). Most of the increase will go toward the NSF Supercomputing Centers and networking activities, both of which support research in all areas of science, mathematics, and engineering. The Geosciences directorate will receive an increase of 18.1%, mostly as part of the government-wide global change initiative.

The FY 1991 budget for the DMS is set to increase by 6.7% to \$73.7 million, a significant scaling-back from the request for FY 1990, when the NSF asked for \$76.1 million for mathematics. The lower request level is probably in response to tough budgetary times for the government as a whole. Indeed, other NSF divisions saw a similar belt-tightening in the FY 1991 request levels.

A portion of the increase requested for the DMS for 1991 will support a number of Foundation-wide activities, such as the new Faculty Awards for Women program, designed to provide multi-year support for outstanding senior women scientists. The Special Projects Office in the DMS will handle curriculum development in undergraduate mathematics, extending reform projects to courses other than calculus. The DMS will continue efforts to expand interactions between mathematics and other fields of science, especially biology, and expects to continue the "regional geometry institutes." The DMS also plans to set aside about \$1 million, distributed among the different disciplinary programs, to provide grants to young investigators.

Science and Technology Centers

The STC program got off the ground in late 1988, when the Foundation funded eleven centers. Mathematics research is supported on a number of these grants (see *Notices*, February 1989, page 154). The STCs are designed to incorporate research, education, and technology transfer to address scientific and engineering problems requiring an interdisciplinary approach. Some in the scientific community have expressed apprehension that the centers may eventually drain funds for individual researchers.

The NSF received about 150 proposals for the second round of STCs, to be funded during FY 1990. The Foundation's decision to delay funding to FY 1991 came as a result of the double blow of a smaller increase than requested, followed by the across-the-board spending reductions. Realistically, though, the funding won't be much delayed. The interdisciplinary panel reviews and site visits originally set the award date in August 1990, and it's been pushed forward to October 1990, the beginning of FY 1991.

Ann Boyle, a program director for Algebra and Number Theory and DMS coordinator for the STC program, says she's received inquiries from investigators concerned about the future of the program. Uncertainty over whether Director Bloch, a strong proponent of the STC program, will be reappointed in August has increased worries over the fate of the program. However, Boyle says the NSF would lose a lot of credibility if after all the effort put into the current batch of proposals, it made no new STC awards. In addition, because this is the second STC competition, she notes, there was a greater proportion of strong proposals, since proposers now have a better idea of what the program is all about.

Boyle says there were about eight mathematics proposals in the current competition, but, given the interdisciplinary nature of the program, other proposals may have mathematics components. Thirty site visits to the top proposing institutions are currently under way. In this round, the NSF plans to add eight to ten new STCs.

Educational Activities

For FY 1991, the NSF itself has come out with a hefty proposed increase of 23% for Science and Engineering Education, a perennial favorite for Congressional budgetary boosts. The largest increase, a whopping 47%, would go to the division of Undergraduate Science, Engineering, and Mathematics Education (USEME). If the request becomes reality, the Course and Curriculum program, which oversees the calculus curriculum reform projects, would double its current budget of \$4 million. Part of the new funds are intended to allow USEME to participate financially in the curriculum development projects to be developed in the research divisions.

Under the FY 1991 request, USEME's Instruction and Laboratory Improvement (ILI) program would see an increase of nearly 50%. The increase would be mostly as a result of consolidating the program with USEME; right now, ILI grants to doctoral-granting institutions are handled through the research divisions, rather than through USEME. In addition, plans are being developed to allow more comprehensive ILI projects

including personnel and materials development, rather than only equipment.

Allyn Jackson
Staff Writer

The following text was prepared by the staff of the Division of Mathematical Sciences of the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1991.

Mathematical Sciences

Summary of Request

The FY 1991 Request for the Mathematical Sciences Subactivity is \$73.72 million, an increase of \$4.6 million, or 6.7 percent, over the FY 1990 Current Plan of \$69.12 million.

(Millions of Dollars)

Program Element	FY 1989 Actual	FY 1990 Current Plan	FY 1991 Request
Classical Analysis	\$5.81	\$5.97	\$6.22
Modern Analysis	5.78	5.96	6.21
Geometric Analysis	5.89	6.31	6.68
Topology & Foundations	7.04	7.24	7.55
Algebra & Number Theory	9.85	10.12	10.56
Applied Mathematics	8.13	8.30	8.70
Statistics & Probability	7.26	7.44	7.81
Computational Mathematics	4.74	4.91	5.22
Special Projects	11.52	12.87	14.77
Total, Subactivity	\$66.02	\$69.12	\$73.72

Scientific Overview

The Mathematical Sciences Subactivity fosters the creation and development of mathematical ideas, methods, and techniques and promotes their use in improving our understanding of physical, biological, engineering, and social phenomena. Support for significant research and related infrastructure activities ensures the continuing vitality and long-range health of the discipline. All disciplines of the mathematical sciences, from those with the sharpest intrinsic focus to those that reach out to other areas of knowledge, are supported to encourage interaction and provide a healthy balance among them.

The core of the Foundation's program in the mathematical sciences is the support of standard research projects. Collaborative research efforts, inclusion of graduate students and postdoctoral researchers, and development and use of computational techniques are encouraged where appropriate.

Much of the current excitement in mathematics stems from the interactions between various subdisciplines and between mathematics and other areas of science and engineering:

- The Geometry Supercomputer Project based at the University of Minnesota involves researchers from across the country and Europe. Its Minimal Surface Team has developed a "Surface Evolver" program that models geometrically the evolution of surfaces driven by various forces such as surface tension, crystalline surface energy, gravity and pressure. The program will be an aid in developing and testing conjectures about surfaces. It is available to the public and will run on several different machines.
- How closely may equal-sized spheres be packed in space? This problem, and its analogues in more than three dimensions, is very important in communications theory where the packing solutions are used to determine efficient error-correcting codes. Recently Dr. Noam Elkies of Harvard University used seemingly unrelated concepts from number theory to find sphere packings, in higher dimensions, that are denser than any previously known.

The above examples reflect the impact of mathematics research on fields as diverse as materials science and information technology. They are typical of recent developments throughout mathematics and exhibit two related phenomena:

- Many of the most fundamental advances are being made by people with deep understanding of a wide range of mathematical and scientific topics.
- Application and theoretical development are operating in mutually enriching ways, with the computer's extension of the reach and power of mathematics a driving factor.

These observations have profound implications for the training of graduate students and for the continuing development of established researchers.

The Mathematical Sciences Subactivity also supports, through its Office of Special Projects, various efforts that cut across the mathematical sciences, including: research institutes and centers; postdoctoral research fellowships; research conferences, workshops and special years; shared scientific computing research equipment; and undergraduate programs managed in collaboration with the Science and Engineering Education Activity.

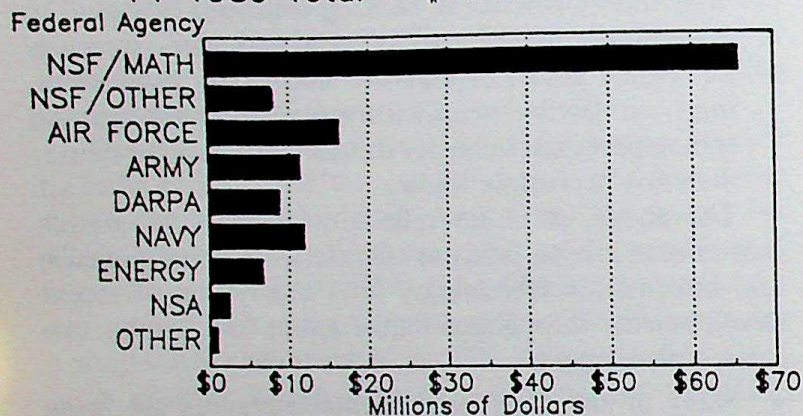
During the last few years, support for the mathematical sciences has emphasized improving the pool of talent entering the field. Significant gains have been made through added support for graduate students, postdoctoral researchers and undergraduate faculty and students. Support for undergraduate curriculum development in calculus was initiated in FY 1988 in cooperation with Science and Engineering Education.

The chart below illustrates the crucial role played by NSF in the federal support of academic research in the mathematical sciences. In all areas of the mathematical sciences, Foundation-supported research involves a broader range of basic research topics than the more project-oriented research sponsored by the mission agencies.

NSF coordinates its support of research in the mathematical sciences with its counterpart federal agencies through the Interagency Committee for Extramural Mathematics Programs (ICEMAP). This group meets regularly to share information on policies of support and to discuss areas of emphasis and of unusual scientific opportunity.

Federal Academic Mathematics Funding

FY 1989 Total = \$133.26 Million



Changes Between FY 1990 Request and FY 1990 Current Plan

Program Element	(Millions of Dollars)		
	FY 1990 Request	FY 1990 Current Plan	Change Percent
Classical Analysis	\$6.47	\$5.97	-7.7%
Modern Analysis	6.46	5.96	-7.7
Geometric Analysis	7.16	6.31	-11.9
Topology & Foundations	7.87	7.24	-8.0
Algebra & Number Theory	11.15	10.12	-9.2
Applied Mathematics	9.21	8.30	-9.9
Statistics & Probability	8.21	7.44	-9.4
Computational Mathematics	5.85	4.91	-16.1
Special Projects	13.67	12.87	-5.9
Total, Subactivity	\$76.05	\$69.12	-9.1%

The FY 1990 Current Plan is \$69.12 million, a decrease of \$6.93 million (9.1 percent) from the FY 1990 Budget Request due to Congressionally mandated reductions. This represents an increase of \$3.10 million (4.7 percent) over the FY 1989 level.

Within the FY 1990 allocation, priority will be given to modern geometric mathematics and to undergraduate course and curriculum development, particularly

in calculus. Emphasis is also placed on interaction with other disciplines, computational mathematics, appropriate support for small research groups, and human resources issues of importance to the field.

FY 1991 Budget Request

Program Element	(Millions of Dollars)		
	FY 1990 Current Plan	FY 1991 Request	Change Percent
Classical Analysis	\$5.97	\$6.22	4.2
Modern Analysis	5.96	6.21	4.2
Geometric Analysis	6.31	6.68	5.9
Topology & Foundations	7.24	7.55	4.3
Algebra & Number Theory	10.12	10.56	4.3
Applied Mathematics	8.30	8.70	4.8
Statistics & Probability	7.44	7.81	5.0
Computational Mathematics	4.91	5.22	6.3
Special Projects	12.87	14.77	14.8
Total, Subactivity	\$69.12	\$73.72	6.7%

The FY 1991 Budget Request of \$73.72 million is \$4.6 million (6.7 percent) above the FY 1990 Current Plan. The main elements of this increase are expanded participation of women and minorities, enhanced undergraduate programs, and strengthened support for standard research projects with emphasis on graduate students and equipment.

Within Special Projects, the increase is directed to the following priorities:

- Undergraduate course and curriculum development. Efforts will continue in calculus and expand the focus to other introductory courses such as precalculus, discrete mathematics, geometry, and statistics.
- Activities in conjunction with the Alliances for Minority Participation program. The focus will be on the critical transitions between high school and undergraduate education and between undergraduate and graduate education, with an emphasis on mentoring graduate education, with an emphasis on mentoring.
- NSF Faculty Awards for Women. New awards will recognize and enhance the research of the increasing numbers of mid-career women with outstanding research credentials in the mathematical sciences.

Across other programs:

- Improving the accessibility of Foundation programs to new investigators is the focus of a \$1.0 million increase. Approximately twenty more new investigators will be supported than would otherwise be possible.
- Increased support for graduate students and equipment is the emphasis of an increase of \$1.4 million.
- Special attention will be given to strengthening research support in areas of opportunity such as interactions with other disciplines, computational mathematics, and incorporating geometric ideas and methods throughout the mathematical sciences.

The following text was prepared by the staff of the Division of Computer and Computation Research in the directorate of Computer and Information Science and Engineering at the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1991.

Computer and Computation Research

Summary of Request

The FY 1991 Request for the Computer and Computation Research (CCR) Subactivity is \$24.28 million, an increase of \$2.30 million or 10.5 percent over the FY 1990 Current Plan of \$21.98 million.

Program Element	(Millions of Dollars)		
	FY 1989 Actual	FY 1990 Current Plan	FY 1991 Request
Computer & Computation Theory	\$6.42	\$6.42	\$6.89
Numeric & Symbolic Computation	2.83	3.33	3.99
Computer Systems Architecture	3.10	3.10	3.21
Software Systems	6.08	5.87	6.13
Software Engineering	2.74	3.26	4.06
Total, Subactivity	\$21.17	\$21.98	\$24.28

Scientific Overview

Computer and computation research discovers the laws which govern problem-solving procedures and develops computing systems which test and utilize the laws. Topics for study include:

- Strategies and algorithms for solving problems, methods of representing and transforming information;
- Programs and software systems for solving large problems or controlling large systems; and
- Machines for executing programs.

parallel computation is a basic theme for much of the research supported in the Subactivity. Promising new parallel computer architectures require new algorithms, languages, tools and software systems to be effective. To develop them, new research is required in theory, problem solving, design and implementation.

Research on large software systems is of current national importance. The Subactivity concentrates on fundamental issues in this area, including formal methods in software engineering, the systematic analysis of software artifacts, and distributed tools and programming environments for collaborative software development. Fundamental research on the theory of software development is required in theory, design and implementation.

and distributed tools and programming environments for collaborative software development. Fundamental research in formal methods and the theory of software engineering often has important practical

application. Researchers at Harvard, Carnegie-Mellon and the University of California at Berkeley have invented a method to create software that checks itself against bugs, worms, and viruses. Their techniques will allow software designers to certify that their programs will be secure or correct.

Both academic and industrial computer and computation research are supported by several agencies of the Federal government. However, with the exception of NSF, most Federal programs support mission-directed research. As with industry, most of these Federal programs concentrate their support at a few academic institutions.

NSF provides support in all areas of computer and computation research to a broad range of academic research institutions. This strengthens the Nation's long-term scientific and technology potential by directly involving teaching faculty, graduate and undergraduate student assistants in research, and by providing incentives for university-industry interaction. About 50 percent of academic research in software and 75 percent of research in computing theory is funded by this Subactivity. Close collaboration is maintained with other federal agencies through the Office of Science and Technology Policy, formal interagency agreements and informal interaction of program officers.

Changes Between FY 1990 Request and FY 1990 Current Plan

	(Millions of Dollars)		
	FY 1990 Request	FY 1990 Current Plan	Change Percent
Program Element			
Computer & Computation Theory	\$6.71	\$6.42	-4.3%
Numeric & Symbolic Computation	2.95	3.33	12.9
Computer Systems Architecture	3.60	3.10	-13.9
Software Systems	6.87	5.87	-14.6
Software Engineering	3.54	3.26	-8.2
Total, Subactivity	\$23.67	\$21.98	-7.2%

The FY 1990 Current Plan is \$21.98 million, a decrease of \$1.70 million (7.2 percent) from the FY 1990 Request of \$23.67 million, due to Congressionally-mandated reductions. The effects of these reductions are: (1) fewer awards than planned in four programs, (2) decreased emphasis on new computer architectures in order to emphasize software research for high performance computing, and (3) reduction in scope of new efforts in software engineering. The Numeric and Symbolic Computation increase of \$0.38 million results from the transfer of research on automatic theorem proving from Software Systems to facilitate coordination between closely related research topics.

FY 1991 Budget Request

(Millions of Dollars)

Program Element	FY 1990 Current Plan	FY 1991 Request	Change Percent
Computer & Computation Theory	\$6.42	\$6.89	7.3%
Numeric & Symbolic Computation	3.33	3.99	19.8
Computer Systems Architecture	3.10	3.21	3.5
Software Systems	5.87	6.13	4.4
Software Engineering	3.26	4.06	24.6
Total, Subactivity	\$21.98	\$24.28	10.5%

The FY 1991 Request increases emphasis on fundamental software research throughout all program elements of the Subactivity. It focuses previous efforts in parallel and distributed systems and scientific computing on the problems of high performance computing by increasing support in the Numeric and Symbolic Computing program element by \$0.66 million. It adds support for basic research on methods of software creation by increasing the Software Engineering program element by \$0.80 million.

In both public and private sectors, unreliable and inefficient software continues to be a major source of risk to life, property and money. Expansion of fundamental software research will provide methods for increasing software reliability and performance, for testing and validating critical software systems to reduce the risk of failure, and for improving computer, network, and information security and integrity. The potential payoff from this research is exemplified by recent results which indicate that certain kinds of computer programs can be made practically immune to defects. Using a method of constructing software called "k-testability," Richard Lipton of Princeton University has demonstrated that the probability of software failure can be reduced greatly by slowing slightly the speed or performance of the software. Such tradeoffs may be desirable for high risk computer applications.

Finally, new research will be started in software for use of application-specific computing systems, jointly with the Microelectronics Information Processing Systems Subactivity.

The following text was prepared by the staff of the directorate of Science and Engineering Education at the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1991.

Information, Robotics, and Intelligent Systems

Summary of Request

The FY 1991 Request for the Information, Robotics, and Intelligent Systems (IRIS) Subactivity is \$22.88 million, an increase of \$2.90 million, or 14.5 percent, over the FY 1990 Current Plan of \$19.98 million.

Program Element	FY 1989 Actual	FY 1990 Current Plan	FY 1991 Request
Knowledge and Database Systems	\$7.68	\$7.75	\$9.12
Robotics and Machine Intelligence	6.04	6.24	6.55
Interactive Systems	2.66	2.66	3.05
Information Technology and Organizations	2.76	3.33	4.15
Total, Subactivity	\$19.14	\$19.98	\$22.88

Scientific Overview

This Subactivity supports research to improve basic understanding and design of information systems that enhance our ability to work and live in complex environments. Research in this Subactivity focuses on how to provide the best computational structures and physical devices to facilitate the use of information. Research to improve understanding of economic and societal consequences of advanced network technologies in organizations and other distributed work environments is also supported.

Databases have become central elements of social and economic functioning, and key factors in scientific research. Similarly, as ways were discovered to automate the transformation of knowledge about processes into physical work, robots and other automated machines have proliferated. Both phenomena have obvious effects on industrial development and growth, and major consequences for national economic competitiveness.

Past technology improvements provide only a hint of the potential usefulness of electronic information processing in the future. Continued progress requires improvements in both theories and techniques for manipulating and using information as well as exploiting the power of new computing machinery. Major opportunities exist to improve the utilization of automated systems and shared knowledge bases, and to exploit computers and intelligent agents in performing complex tasks.

Progress requires fundamental research and engineering experimentation on representing knowledge in machines, and automating complex processes of reasoning and understanding, inference, learning, reasoning, and problem solving. Equal attention is needed to improve the interaction between people and computers by understanding the cognitive requirements of human information processing, and by improving the modes of interaction, such as graphic display, multi-media interfaces, and high-level mechanisms for human-machine interaction. Fundamental research is also needed on problems related to advanced scientific communications networks, applications, such as computer mediated communications, digital journals, collaborative work systems, and retrieval of information from distributed databases.

FY 1991 Budget Request

(Millions of Dollars)

Program Element	FY 1990 Current Plan	FY 1991 Request	Change Percent
Knowledge and Database Systems	\$7.75	\$9.12	17.7%
Robotics and Machine Intelligence	6.24	6.55	4.9
Interactive Systems	2.66	3.05	14.6
Information Technology and Organizations	3.33	4.16	25.0
Total, Subactivity	\$19.98	\$22.88	14.5%

The FY 1991 Request will maintain base support in all program elements to take advantage of computing technologies such as new sensors, parallel computers and high bandwidth communication networks. These technologies, unavailable just a few years ago, are rapidly changing the way information from the physical environment is collected, stored, and used as knowledge for personal and organizational activities.

Most of the increment (\$2.60 million) will be allocated to enhance research in two priority areas located primarily in two program elements: Knowledge and Database Systems, and Information Technology and Organizations.

Both of these activities will support work at the intersection of computer science, artificial intelligence, and a variety of scientific and engineering disciplines. Multi-disciplinary teams will be supported to encourage cross-fertilization and to facilitate knowledge transfer between academic and industrial research communities.

- **Scientific Databases** (\$1.75 million): This increment in the Knowledge and Database Systems and Interactive Systems programs is to initiate research to advance the database technology essential for improving productivity and enabling new forms of data analysis and knowledge processing in scientific and engineering fields. The goal is to develop new methodologies and enterprises that will be sustained by user disciplines. Application areas in the biological and geological sciences will be targeted so that research results will be useful to initiatives involving global change and the human genome.
- **Collaboration Technology** (\$0.85 million): The goal of this research, to be funded primarily within the Information Technology and Organizations program, is to improve methods of using information technologies to improve coordination, communication and resource management of human collaborative activity. Results of this research will contribute to new knowledge and improved tools for humans to function more efficiently in the distributed workplace.

Changes Between FY 1990 Request and FY 1990 Current Plan

(Millions of Dollars)

Program Element	FY 1990 Request	FY 1990 Current Plan	Change Percent
Knowledge and Database Systems	\$8.21	\$7.75	-5.8%
Robotics and Machine Intelligence	6.77	6.24	-7.8
Interactive Systems	3.39	2.66	-21.5
Information Technology and Organizations	3.27	3.33	1.8
Total, Subactivity	\$21.64	\$19.98	-7.7%

The FY 1990 Current Plan is \$19.98 million, a decrease of \$1.67 million (7.7 percent) from the FY 1990 Request of \$21.64 million, due to Congressionally-mandated reductions. This represents a \$0.84 million increase over FY 1989. Priorities have been maintained in coordination theory and technology within the Information Technology and Organization Program and Machine vision and sensing within the Robotics and Machine Intelligence Program. In line with protecting these priorities, Interactive Systems is level funded.

The following text was prepared by the staff of the Division of Advanced Scientific Computing in the directorate of Computer and Information Science and Engineering at the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1991.

Advanced Scientific Computing

Summary of Request

The FY 1991 Request for the Advanced Scientific Computing (ASC) subactivity is \$62.58 million, a decrease of \$0.25 million, or 0.4 percent, from the FY 1990 Current Plan of \$62.83 million.

Program Element	(Millions of Dollars)		
	FY 1989 Actual	FY 1990 Current Plan	FY 1991 Request
Centers	\$53.79	\$60.21	\$59.59
New Technologies	1.79	2.62	2.99
Total, Subactivity	\$55.58	\$62.83	\$62.58

Scientific Overview

The Advanced Scientific Computing Subactivity provides the science and engineering basic research community access to advanced computational facilities through support of four nationally accessible Supercomputer Research Centers:

- The San Diego Supercomputer Center at the University of California at San Diego;
- The National Center for Supercomputing Applications at the University of Illinois;
- The Pittsburgh Supercomputing Center; and
- The Cornell National Supercomputer Facility at Cornell University.

The Subactivity also supports basic research on methods and technologies for high performance scientific computing.

The Centers serve the U.S. academic research community, support software development to maximize productivity, and train new users. In addition, the Centers, working jointly with industry, are leaders in research on supercomputing systems including state-of-the-art supercomputers and software, peripherals for data storage, retrieval and display, network connections, and special purpose processors.

State-of-the-art high performance computers are essential to leadership in contemporary scientific and engineering research, as they permit researchers to explore otherwise unmanageable problems. Operating at speeds of from ten to one hundred times faster than mainframe computers, or up to billions of operations per second, supercomputers are used to analyze data and to simulate

processes at levels of complexity and detail that inform our most advanced notions of reality.

The range and diversity of research addressed is vast, from modelling the surfaces of viruses to simulating the dynamics of thunderstorms; from performing calculations to reveal new features of nucleon masses, to building models of international economic activity. As a result, the centers serve scientists and engineers from all the Foundation activities. Each year, more than 5,000 university faculty, postdoctoral, graduate and undergraduate students, and industrial researchers from across the nation use the Centers. These researchers come from all types of institutions and from every field.

The NSF Supercomputing program provides researcher William Krakauer of the College of William and Mary ready access to the advanced high performance computing technology required for his research on tungsten. In physical processes such as catalysis and corrosion, the surface of a material are where all the action takes place. Using the Cornell National Supercomputer Facility and proceeding from equations representing atomic interactions, Dr. Krakauer has simulated the behavior of a small number (30) of tungsten atoms in an attempt to predict surface properties at a variety of temperatures. Faster supercomputers in the future will allow the simulation of larger numbers of atoms for more realistic sample sizes.

To meet the growing demand for access and speed, the computing systems at the Centers were upgraded in 1989. Major equipment was added for data storage and scientific visualization, and new supercomputers were acquired. These upgrades resulted in a doubling of raw processing capacity, and a very substantial improvement on the capability available to the U.S. research community.

In addition to providing access to supercomputers, the Centers provide a broad array of critical user services, specialized graphics and visualization systems, applications software libraries and consulting services, training workshops, and related activities. Educational activities range from special programs for high-school students and undergraduates, through established disciplinary research programs at the postdoctoral level.

The Centers also receive support from industrial affiliates, and work with them on new ways to use high performance computing for increased productivity. For example, ALCOA Laboratories' partnership with the Pittsburgh Supercomputing Center has resulted in the ability to test a new can design more quickly and at a cost of about \$2,000 per test, rather than \$100,000 per test required for traditional physical prototyping.

NSF activities in this area are coordinated with the more mission-oriented activities of other Federal agencies, most notably the Department of Energy, Department of Defense, the National Oceanic and Atmospheric Administration, and the National Aeronautics and Space Administration.

spheric Administration, and the National Aeronautics and Space Administration. This cooperation encourages the exchange of skills, applications, software operations and management experience, and optimizes facility utilization.

Changes Between FY 1990 Request and FY 1990 Current Plan

Program Element	(Millions of Dollars)		
	FY 1990 Request	FY 1990 Current Plan	Change Percent
Centers	\$69.03	\$60.21	-12.8%
New Technologies	2.66	2.62	-1.7
Total, Subactivity	\$71.69	\$62.83	-12.4%

The Subactivity is funded at \$62.83 million in FY 1990, \$8.86 million (12.4 percent) below the Request level. The reduction is taken in the Supercomputer Centers program element and reflects the lower costs due to the phasing out of support for the John von Neumann Center. This nets out to a \$6.42 million real increase over FY 1989, for systems upgrades at the four remaining centers. The New Technologies research program element is maintained near the FY 1990 Request level, which is an increase of \$0.83 million, or 46.4 percent, over FY 1989, in order to bolster software research for high performance computing applications.

FY 1991 Budget Request

Program Element	(Millions of Dollars)		
	FY 1990 Current Plan	FY 1991 Request	Change Percent
Centers	\$60.21	\$59.59	-1.0%
New Technologies	2.62	2.99	14.3
Total, Subactivity	\$62.83	\$62.58	-0.4%

The Request supports existing upgrade programs at the four national centers at the cooperative agreement levels, and enhances research activities in technologies supporting high performance computing. Although the decrease for the Centers program element is \$0.62 million, this represents a net increase of \$7.38 million over the FY 1990 Current Plan for the four remaining centers, which will support renewal and upgrades. Computing services and resources and educational activities will be extended to a broader national constituency. A wider spectrum of computational science and engineering research activities will be addressed through the New Technologies program

element, with special attention to topics where the research domains of computer science and disciplinary computing intersect.

The Subactivity will support incorporation of new highly-parallel supercomputers into operations at the national centers. Research related to mapping promising applications onto these new systems, and increasing support for parallel computing on conventional production supercomputer systems will be accelerated.

Overall system performance and research productivity can be significantly increased by using more efficient software and algorithms. Along with expansion of application libraries, upgrading dataset management systems, and improvement of visualization and graphics capabilities, the Subactivity will expand its support of research on new computational algorithms and software development.

Research will be supported to develop automated tools for improvement of user software and to provide users with a more robust, friendly computing environment. The interface to systems is central in this regard. Software is required to enable researchers to move seamlessly from personal workstations, through local computing systems, to the national centers, accessing applications software and tools in each environment. Implementation of a standard operating environment in all centers systems is central to this goal.

In order to enhance the scientific environment of the centers, additional support will be offered for research associate programs, visitors programs, research workshop series, summer research institutes and extended programs for select disciplinary topics.

Cooperative efforts between the national centers in such areas as development of on-line tools and documentation, management of large databases, scientific visualization and software development will be initiated. Emphasis will be placed on development of generic tools for use at the national centers with distribution to state and local supercomputer centers.

The centers have developed extensive education and training programs, resources, and expertise and have put into place mechanisms for propagating these efforts. Education and training programs will span the entire user base, with special emphasis on introducing the methods and experience of scientific computing to undergraduate students. The centers will continue to integrate use of the supercomputer systems into undergraduate curricula of many disciplines at both local and non-local institutions. Opportunities for training scientists and students at institutions lacking formal affiliation with the centers will be made available, along with special programs for researchers at minority institutions.

The following text was prepared by the staff of the Division of Networking and Communications Research and Infrastructure in the directorate of Computer and Information Science and Engineering at the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1991.

Networking and Communications Research and Infrastructure

Summary of Request

The FY 1991 Request for the Networking and Communications Research and Infrastructure (NCRI) Subactivity is \$31.29 million, an increase of \$9.10 million, or 41.0 percent, over the FY 1990 Current Plan of \$22.19 million.

Program Element	(Millions of Dollars)		
	FY 1989 Actual	FY 1990 Current Plan	FY 1991 Request
NSFNET	\$13.59	\$15.96	\$22.04
Networking and Communications Research	4.02	6.23	9.25
Total, Subactivity	\$17.61	\$22.19	\$31.29

Scientific Overview

The Networking and Communications Research and Infrastructure Subactivity supports the development and operation of the NSFNET computer network for research and education, and fundamental scientific and engineering research on communications theory and data networks. The research and network service functions are integrated, creating the mechanism for fast translation of research into practice and driving research toward new problems based on experience.

This provides a vehicle for testing research results and a natural opportunity for university/industry collaboration. In addition to stimulating academic research in a highly leveraged way, this approach affords the use of new technology developed and deployed by the telecommunications industry, such as high bandwidth fiber optic communications lines, at low marginal cost.

NSFNET, a network of computer networks, or "internet", was created in 1986 to provide access to the NSF Supercomputer Centers for the nation's computational science community. It has grown into a transcontinental backbone network interconnecting more than a dozen autonomous regional networks, which in turn connect nearly 300 academic, industrial and governmental research institutions. Through this network, researchers can link to each other for research collaboration, and to unique resources such as advanced supercomputers, radio telescope arrays and biotechnology databases.

Collaborative development of national and international networking with other federal agencies results in effective interaction across the Nation. The NSFNET backbone is the centerpiece of the internet composed of connected Federal agency networks, regional mid-level networks, and local wide area networks. Together, they form the prototype of a national research and education network.

NSF is leading the Federal interagency implementation of the national research and education network. Cooperating closely with five other agencies to interconnect their cross-country research networks, the NSFNET backbone has been upgraded and reconfigured to accommodate substantial growth in usage.

Although operational and pilot networks are the most visible parts of the Subactivity, progress depends on an aggressive program of research in communications sciences and engineering. Projects are supported at the forefront of technology and application. For example, research performed by principal investigators Ezio Biglieri and Kung Yao at the University of California, Los Angeles, has resulted in new architectures to implement advanced signal processing algorithms used in high-speed data communication systems. The new machines are fault tolerant, and a major advance for insuring reliable, secure computer networks.

Research often benefits from substantial industrial participation and is positioned to transfer directly into practice, thereby enhancing the Nation's industrial strength. This is demonstrated in a joint initiative of NSF, DARPA and U.S. industry, which began in 1989. It involves the creation and operation of national "testbed" networks for advanced research on problems associated with super-high speed data transmission. Each testbed uses an advanced scientific research application to stress and improve the underlying technology. A significant feature of the project is very substantial industrial participation and cost sharing. Industry partners include the nation's major communications common carriers and computer vendors and their research laboratories. They are working with several National Laboratories, NSF Supercomputer Centers, and university researchers in a truly national program.

Changes Between FY 1990 Request and FY 1990 Current Plan

Program Element	(Millions of Dollars)		
	FY 1990 Request	FY 1990 Current Plan	Change Percent
NSFNET	\$19.63	\$15.96	-18.5
Networking and Communications Research	7.50	6.23	-16.9
Total, Subactivity	\$27.13	\$22.19	-18.2

The FY 1990 Current Plan is \$22.19 million, a decrease of \$4.94 million (18.2 percent) from the request level of \$27.13 million, due to Congressionally-mandated reductions. The decrease is spread over all programs with priority given to assistance to regional networks of the NSFNET and to primarily undergraduate institutions. The FY 1990 Current Plan also represents an increase of \$4.58 million over the FY 1989 level, which will sustain the planned NSFNET activity.

FY 1991 Budget Request

(Millions of Dollars)			
Program Element	FY 1990 Current Plan	FY 1991 Request	Change Percent
NSFNET	\$15.96	\$22.04	38.1%
Networking and Communications Research	6.23	9.25	48.5
Total, Subactivity	\$22.19	\$31.29	41.0%

The FY 1991 Request continues the capacity expansion of the NSFNET backbone network, primarily for increasing the transmission speed from 1.5 million bits per second (T1) to 45 million bits per second (T3). Additional funding will be provided to regional networks to assist their capacity expansion in cases where scientific need is demonstrated. User services will be expanded and more closely coordinated with those offered by other agencies supporting research networks. This will initiate service integration, and create a single point of contact and assistance for Internet users.

The requested increase for the Networking and Communications research program element will be used for three purposes:

- The number of awards for disciplinary fundamental research will be increased;
- Funding is increased for the network technology component of program in coordination theory and collaboration technology funded jointly with two other Subactivities in CISE; and
- The coordinated interagency program of research and technology demonstration in networks operating at speeds in excess of a billion bits per second will continue into its third year.

The following text was prepared by the staff of the directorate of Science and Engineering Education at the NSF and was submitted to Congress as part of the Administration's Budget Request for the Fiscal Year 1991.

Science and Engineering Education Summary of Request

The FY 1991 Request for the Science and Engineering Education (SEE) Activity is \$251.00 million, an increase of \$46.73 million, or 22.9 percent, over the FY 1990 Current Plan of \$204.27 million.

Subactivity	(Millions of Dollars)		
	FY 1989 Actual	FY 1990 Current Plan	FY 1991 Request
Teacher Preparation and Enhancement	\$63.66	\$81.00	\$89.60
Materials Development, Research, and Informal Science Education	43.99	48.00	61.50
Undergraduate Science, Engineering, and Mathematics Education	28.00	34.00	50.00
Research Career Development	30.98	36.90	44.90
Studies and Program Assessment	4.50	4.37	5.00
Total, Activity	\$171.13	\$204.27	\$251.00

NSF Role

The responsibility of the Science and Engineering Education (SEE) Activity is to define and fund programs and projects that support the educational aspects of the Foundation's mission. SEE also plays a major role in developing human resources for science and engineering. The magnitude of the educational effort in the United States and the long lead times needed for new programs, materials, and methods require a continuing and significant involvement in this area. Sustaining this level of commitment, visibility, and continuity is responsive to the national concern with science, mathematics, and engineering education and will draw the best, most creative people into the process.

SEE fulfills this responsibility by conducting leadership activities that inform and stimulate other sectors, and by supporting original work and other merit-based, high-leverage activities that serve as prototypes and models of excellence for the Nation. A major objective is to encourage appropriate cooperation among academic scientists, engineers, educators and the private sector for intellectual partnerships as well as for leveraging funds.

The National Science Foundation is active at all levels of education—precollege, undergraduate, graduate, and postgraduate. SEE serves as the focal point for education at NSF. In this role SEE manages the programs for which it has sole budgetary responsibility, and serves in a coordinating and facilitating capacity for other administrative units throughout the Foundation.

The role of SEE is to help insure that:

- a high-quality precollege education in science and mathematics is available to enable those who are interested and talented to pursue technical careers, especially in science and engineering, as well as to

- provide a base for understanding by all citizens;
- those who select scientific and engineering careers have available the best possible professional education in their disciplines. While other NSF programs provide apprenticeship training for the next generation of scientists and engineers through research support, SEE's efforts (in addition to graduate and postdoctoral fellowships) concentrate on the educational structure leading to this stage; that is, on the teachers, students, laboratory, and classroom resources that remain important through undergraduate and graduate studies;
- opportunities are available at the college level for interested nonspecialists to broaden their science, mathematics, and technical perspective and understanding to familiarize them with the principles, practices, techniques, and limits of science;
- informal science education programs are available to maintain public awareness of and interest in scientific and technological developments affecting their lives; and
- the educational pipelines leading to careers in science, engineering and mathematics yield sufficient numbers of well-educated individuals to meet the needs of the U.S. technical workforce. Increasing the participation in such careers of minorities, women, and the disabled receives special attention at all educational levels.

Several SEE programs have specific requirements for cost sharing and other forms of funds leveraging. Data for FY 1989 demonstrate that precollege teacher enhancement and teacher preparation projects generate non-NSF funds equal to one-half of NSF funds invested, while projects in instructional materials development and informal science education generate external funding equal to three times the amount of the NSF awards. At the undergraduate level, there is a 1:1 matching requirement for equipment purchases.

SEE coordinates its activities closely with other relevant areas of NSF and with other agencies, e.g. NASA, the Department of Energy and the Department of Education (DoEd). Such coordination is intended to promote maximum use of expertise in the agencies, to minimize program overlap, and to optimize the use of limited Federal resources. Within the Foundation, the undergraduate instrumentation support is an example of an integrated management effort led by the SEE Activity and involving all of the Research Directorates. Externally, NSF and DoEd have collaborated in supporting a number of projects, including the International Study of Mathematics, the International Science Study, International Comparison of 13-year-olds, and a study of state-based science and math indicators at the precollege level. NSF, NASA, and the Department of Energy have jointly co-funded the National Academy of Science's "Mathematical Sciences Education Board".

Changes Between FY 1990 Request and FY 1990 Current Plan

Subactivity	(Millions of Dollars)		
	FY 1990 Request	FY 1990 Current Plan	Change Percent
Teacher Preparation and Enhancement	\$68.50	\$81.00	18.2
Materials Development, Research, and Informal Science Education	49.00	48.00	-2.0
Undergraduate Science, Engineering, and Mathematics Education	30.00	34.00	13.3
Research Career Development	38.00	36.90	-2.9
Studies and Program Assessment	4.50	4.37	-2.9
Total, Activity	\$190.00	\$204.27	7.5

The FY 1990 Current Plan is \$14.27 million more than the FY 1990 Request of \$190.00 million, and \$33.14 million more than FY 1989, a 19.4 percent increase. The distribution of the increase, as specified by Congress, is to the pre-college Teacher Preparation and Enhancement Subactivity and to the Career Access Program of the Undergraduate Science, Engineering, and Mathematics Education Subactivity. All Subactivities are then reduced by the Gramm-Rudman-Hollings sequestration and other mandated across-the-board reductions to arrive at the Current Plan.

Across the Activity in FY 1990:

- precollege programs total \$140.37 million (\$21.22 million more than FY 1989, a 17.8 percent increase)
- undergraduate programs total \$34.00 million (\$6.00 million more than FY 1989, a 21.4 percent increase)
- graduate programs total \$29.9 million (\$5.92 million more than FY 1989, a 24.7 percent increase).

FY 1991 Budget Request

Subactivity	(Millions of Dollars)		
	FY 1990 Current Plan	FY 1991 Request	Change Percent
Teacher Preparation and Enhancement	\$81.00	\$89.60	10.6
Materials Development, Research, and Informal Science Education	48.00	61.50	28.1
Undergraduate Science, Engineering, and Mathematics Education	34.00	50.00	47.1
Research Career Development	36.90	44.90	21.7
Studies and Program Assessment	4.37	5.00	14.4
Total, Activity	\$204.27	\$251.00	22.9

The Teacher Preparation and Enhancement Subactivity will continue to focus on improvement of precollege science and mathematics education through effective preservice and inservice teacher training. In FY 1991, emphasis will be placed on the Statewide Initiative

to forge strong Federal-State partnerships to restructure pre-college education throughout the Nation. This effort will assist states in meeting the national education goals that are being developed as a result of the September 1989 Education Summit.

The Materials Development, Research, and Informal Science Education Subactivity will continue to focus on the need for a consistent pattern of elementary and secondary school science and mathematics instruction. A major effort will be continued in FY 1991 to develop improved instructional materials for science in the secondary schools. Informal science activities and research about the teaching and learning process will also be emphasized. Programs to develop and demonstrate the use of modern technology in addressing educational problems will continue.

Programs in the Undergraduate Science, Engineering, and Mathematics Education Subactivity will increase substantially in FY 1991. In addition to the continued emphasis on strengthening college instrumentation and laboratories (College Science Instrumentation Program), the effort will be expanded by assuming responsibility for all types of institutions. Comprehensive regional centers for minorities and other model college programs to stimulate the participation of women, minority, and disabled students in curricula leading to science careers will be substantially increased to support approximately 15 centers throughout the Nation by FY 1991. Efforts to enhance the currency of undergraduate faculty and to improve the undergraduate curricula will also increase significantly.

The Research Career Development Subactivity will continue its current efforts. The number of new three-year graduate fellowships will be increased to 1100,

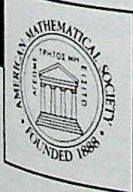
completing the planned doubling of the program from its level of 560 new fellowships in FY 1987. This number includes the continuation of a specially-focused "Women in Engineering" offering to attract more women into the Nation's engineering faculty. The funding will also permit an expansion of the Young Scholars Program for talented high school and middle school students who may be candidates for careers in mathematics, engineering, and the sciences. The amount requested for this Subactivity in FY 1991 includes an increase in the fellowship stipend to \$13,500 per year, and reflects the third step in an administrative adjustment in the funding schedule for the Graduate Fellowships and Minority Graduate Fellowships Programs.

The Studies and Program Assessment Subactivity will continue its studies of national and international trends relevant to science education, the collection and analysis of data on science and engineering education issues, and the support of related policy studies. Efforts to assess the results of NSF education programming will be expanded.

Summary by Educational Level

The allocation to programming at the various educational levels of FY 1990 appropriations and the funds requested for FY 1991 are shown in the following table.

Education Level	(Millions of Dollars)		
	FY 1990 Current Plan	FY 1991 Request	Change Percent
Pre-college	\$140.37	\$165.10	17.6%
Undergraduate	34.00	50.00	47.1
Graduate	29.90	35.90	20.1
Total, Activity	\$204.27	\$251.00	22.9%



GROUP ACTIONS AND INVARIANT THEORY

A. Bialynicki-Birula, J. Carrell, P. Russell, and D. Snow, Editors

(Conference Proceedings, Canadian Mathematical Society, Volume 10)

This volume contains the proceedings of a conference, sponsored by the Canadian Mathematical Society, on Group Actions and Invariant Theory, held in August, 1988 in Montreal. The conference was the third in a series bringing together researchers from North America and Europe (particularly Poland). The papers collected here will provide an overview of the state of the art of research in this area. The conference was primarily concerned with the geometric side of invariant theory, including explorations of the linearization problem for reductive group actions on affine spaces (with a counterexample given recently by J. Schwarz), spherical and complete symmetric varieties, reductive quotients, automorphisms of affine varieties, and homogeneous vector bundles.

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Mathematics Outside of Mathematics Departments

Solomon A. Garfunkel
Gail S. Young

The following article is based on a survey commissioned by the Exxon Education Foundation. Solomon A. Garfunkel is Executive Director of the Consortium for Mathematics and Its Applications (COMAP) in Arlington, Massachusetts. Gail S. Young is professor of mathematics at Columbia Teacher's College. The authors wish to express their deep appreciation to Dr. Richard F. Link, who prepared the sampling plan, oversaw data analysis, and kept two mathematicians statistically on track.

One could view the present state of American mathematics as one of brilliant success or extreme crisis. Mathematics research is more fruitful than ever before in the history of the discipline. Mathematical methods are making real contributions in more and more disciplines, and many new fields are coming into being. Undergraduate mathematics majors who have learned some computer science can get jobs with starting salaries comparable to new mathematics Ph.D.s. New mathematics doctorates are in great demand and, in academia, can get starting salaries comparable to associate professors in the humanities.

On the other hand, the number of mathematics Ph.D.s awarded each year has dropped steadily for more than a decade, and more than half the new doctorates are going to foreign nationals. The number of bachelor's degrees in mathematics, after more than doubling between 1960 and 1970, dropped during the 1980s to the 1960 level. Calculus-level enrollments more than trebled in the fifteen years following 1960. In 1985 calculus accounted for 39% of the mathematics enrollments, whereas remedial and precalculus courses accounted for 52% of the enrollments; advanced courses comprised just 9% (approximately 147,000).

This last fact is especially curious. Consider that, between 1960 and 1983, engineering bachelor's degrees rose from 38,000 to 72,000; biology degrees from 18,000 to 44,000; social science degrees from 16,000 to 25,000. Mathematics has become increasingly important in all of these fields, so one would assume that enrollments

in advanced mathematics would have risen in the period. Where are the students of advanced mathematics? This was the question motivating this study, undertaken in 1988. What we found is that a rise in advanced courses seems to be occurring, but it's not occurring in mathematics departments.

The Study

Anecdotal information and even a cursory look at college and university catalogs indicated that the content of many courses in departments (other than mathematics!) consists entirely or mainly of advanced mathematics. We found such courses not only in the expected places—departments of physics, engineering, computer science—but also in such departments as economics, political science, biology, and management. Therefore, the fact that enrollments in advanced mathematics courses have not risen may reflect an increase in enrollments in mathematics courses being taught outside mathematics departments. This study was prepared to test this hypothesis and to provide a baseline for future studies.

We sampled 425 schools according to a statistically based sampling plan (details are provided in the appendix). Course catalogs were used to select the mathematics department courses which appeared to contain significant mathematical content and which were mathematics at or above the level of calculus. Statistics departments were specifically excluded from the study. In cases where it was difficult to assess the mathematical content of a particular course, we telephoned department chairs to get their appraisal. Once the courses were selected, we obtained enrollment data from the institutions (in addition to other information about the courses).

Our study determined that, each year, there are 170,000 enrollments in advanced mathematics courses being taught outside mathematics departments. The data are presented in the tables at the end of this article, which also sort the numbers according to school type (private or public, university or college), and region. Engineering departments recorded the largest number of enrollments (83,854) with significant mathematics

content. Of the courses represented, 86% developed the mathematical content before it was applied; this was especially true of electrical and chemical engineering courses. Among the mathematical prerequisites mentioned for engineering courses were: calculus, linear algebra, discrete mathematics, and modeling. The term *mathematical maturity* was used in several responses. Interestingly, engineering courses also had the largest average class size: 113 students.)

Next in order of enrollments were business courses. Calculus, linear algebra, and statistics were common prerequisites, with "the mathematics involved in operations research" mentioned quite often. The survey found 61 courses in "business forecasting", which seems to employ large amounts of probability and modeling; these courses are probably required, because they had large enrollments.

The sciences use a great deal of mathematics, and science instructors seem to be expending a great deal of time teaching mathematics before they actually use it in their courses. Courses, such as Mathematical Methods of Physics or Numerical Methods in Biology, specifically train students in the mathematical applications of a scientific discipline. Many of these courses seem to be required. Another interesting development is the prevalence of probability being taught in genetics classes, despite the fact that it is a prerequisite for almost every one of these courses.

Agriculture and the social sciences also recorded courses with advanced mathematics. Many courses stress the need for *mathematical maturity*, with calculus being the formal prerequisite. Discrete mathematics and probability are also common prerequisites in these areas. Our selection of statistics courses from the survey contributes to the small size of the listed enrollments for social science courses. For example, a course entitled "Psychology Statistics" is present in over 50% of the departments surveyed.

Department Responses

We sent a preliminary draft of the first sections of this report to the chairpersons of responding departments, partly as a courtesy, but also in the hope that many would respond to the request in our cover letter that they tell us why they think these courses exist and whether their campuses know that so much mathematics is being taught outside the mathematics departments. We sent out 714 drafts, and have received 292 replies (a response rate of 41%). This is quite good considering the lack of pressure in our letter, the fact that we are clearly not in their fields, and the lack of follow-up.

In fact, many of the replies are quite long and detailed, showing considerable thought and concern. The nature of the comments does not depend on the size or status of the university or college. Although some

of the comments are vitriolic, many appreciate some of the problems of mathematics departments, and some regard the present state as inevitable and even desirable. But overall the comments are critical, and very few of the respondents are really happy with the mathematics departments at their institutions.

The comments can be classified roughly into five categories:

1) The mathematics faculty does not know or appreciate applications.

(This perception is held even in the case of departments which we believe are strongly involved in applied mathematics.) Some typical quotations:

- "[There is an] inability of mathematicians to come to grips with a difference between 'pure' and 'applied' mathematics. Mathematicians of the 'pure' strain look down their noses at the other strains. Thus science and engineering departments feel that their students will not be adequately serviced by math departments. The math departments are unconcerned because they view this as 'bogus' math which they have no interest in offering anyway..."
- "Modern technical fields, with their complex applications of math/technology to real-world problems, have requirements that can't easily be met by isolated, largely theoretical, overly generalized presentations that are not (usually) presented as being useful or interesting to a practical person. The math department courses 'turn off' most of our kids and it's up to us back in the professional departments to turn their enthusiasm back [on] again."
- "Mathematics departments have become so abstractly oriented that their courses are not given any applied content... Most math Ph.D.'s never take an applied math course, so why should they teach it? Our engineering school tried to convince our math department to teach some applied courses but eventually gave up."

2) Mathematics faculty teach mathematics as an art with full abstraction, not as a tool.

- "The content of most math courses focuses on theoretical development. This is not 'bad' per se but leaves most students wondering about the 'what, when, where, and why' of applications... seldom addressed in traditional math courses."
- "Applied departments use math as a tool. An individual topic is analogous to a hammer perhaps. They wish to 'hammer' with it. On the other hand, math departments often become more interested in its description and generalization of the 'hammer' itself."
- "Engineers find math to be a need, not a love. Mathematicians... are out of touch with the real world and are more like mathematical artists than real world scientists."

3) Topics span too many mathematics courses.

- "There is not room...for every student to take the separate courses in differential equations (ordinary and partial), vector and tensor analysis, complex variables, Fourier series, probability,...all these are covered in our one-year course by omitting the detailed proofs and generalization..."
- "Other reasons [for such courses] include the claim that the mathematics needed cannot usually be found in one single mathematics course. Bits and pieces of several courses are wound together."

4) The mathematics departments have not kept up with new applied mathematics.

- "Mathematics departments generally do a lousy job with mathematics their faculty has no training for. Specifically, Shannon's information theory; automata; transformation geometry; graph theory, particularly as employed in practice; algebraic coding theory; polynomial rings and finite fields; computer ability; and, one suspects, probability and statistics."

5) Mathematics courses do not give students the knowledge or the mathematical maturity for further work.

- "An attempt by mathematicians to do 'something for everyone' in basic calculus courses rather than concentrating on a generic mix of basic skills and concepts. Engineering has further suffered by the loss of more preparatory subjects such as analytic geometry."
- "I cannot take it for granted that [students from calculus] are able to use their mathematical skills in problem solving. What appears to be...lacking is the ability to formulate a problem quantitatively and then to solve it using the tools they learned in their calculus course."

We are reporting these opinions as ones widely held in other fields, and we are not endorsing or contradicting them. They are, however, very widely held by our respondents, and therefore must be considered.

Conclusions

As this is to our knowledge a baseline survey, it is difficult to measure any trends. However, anecdotal evidence indicates that there have been substantive increases in enrollments in the courses surveyed. It is certainly clear from the survey that there are more enrollments in advanced work in mathematics outside of mathematics departments than within (approximately 173,000 as compared to 147,000). It is unclear whether this situation is fully understood at individual schools (and in national assessments).

Our follow-up questionnaire to non-mathematics departments indicates that these departments believe the substance of the survey is well-known and understood on their campuses. In fact, it is clear from their responses that the departments believe that mathematics faculty are responsible for and content with this state of affairs.

In a preliminary form of this report we concluded with, "Finally, we should like to stress that this report makes no value judgements on the present state of affairs. It may or may not be healthy for undergraduate instruction in mathematics to be distributed among many departments."

However, on a personal note we find both the survey results and the attitudes of non-mathematics departments deeply disturbing. There is an indicated residue of ill feeling toward mathematics departments. Worse yet, mathematics faculty and curricula are often seen as at best irrelevant and at worst counterproductive. Moreover, respondent after respondent expresses the belief that mathematics departments are unconcerned about issues of course offerings.

Perhaps they are correct. We have shared the results of this survey with a number of mathematicians and mathematics educators and seen no evidence of shock, dismay, or surprise. We are anxious to get reaction from the broader mathematics community.

This survey was commissioned by the Exxon Education Foundation. The purpose of this and several other programs funded by the Foundation was to assess the state and health of undergraduate mathematics education. Moreover these projects were designed to point the way toward needed reform. Given these results, what, if anything, should be done?

We would like to ask that question of the AMS membership. Are these results surprising? Are they troubling? What, if anything, should they spur us to do? At the very least, we hope to begin a public debate. Please write to us at: COMAP, 60 Lowell Street, Arlington, MA 02174. Your ideas and suggestions are important. They can have a direct effect on programs designed to improve the quality of undergraduate instruction and the health of our profession.

Appendix: The Procedure

The four-year colleges and universities can be conveniently categorized as public universities, private universities, public four-year colleges, and private four-year colleges. To account for possible regional differences, we further stratified the four-year institutions according to geographical region: East, South, West, and West. The final variable considered was size of student population, for which we chose small (less than 3,000), medium (3,000-10,000), and large (more than 10,000). Because we wanted to cover as many enrollments as possible, as well as posed to as many institutions as possible, we chose a sample

plan which treated the institution type and geographic location with equal weights but gave a larger weight to the size variable. The effect of this weighted sampling technique is indicated by the following numbers of students attending the institution type versus numbers of students covered by the sample population for each type: public universities (1,724,957/1,241,497), private universities (586,781/453,330), public four-year colleges (3,484,586/1,453,747), and private four-year colleges (1,918,685/434,951). The 425 selected institutions (approximately 25% of all such institutions) were assigned control numbers to insure a "blind" study. Of these, 343 returned catalogs within the time-frame necessary to be included in the survey.

The catalogs were used to select the non-mathematics courses which appeared to contain significant mathematical content. Each course description was reviewed to determine whether it fell within the scope of our survey. Specifically, we were seeking courses which required and used mathematics at, or above, the level of calculus. It should be noted that statistics departments were explicitly excluded from the survey, along with any course cross-listed with the mathematics department.

A survey questionnaire was designed to address the following issues:

- Course frequency
- Course enrollment

- Amount of mathematical content
- Course function (development or the application of mathematics or both)
- Course prerequisites
- Course text
- Accuracy of the catalog description.

While much of the survey questionnaire contained strictly objective information, such as course enrollment and frequency, the mathematical content of each course had to be determined by analyzing the prerequisites and the department chair's impression of the extent of mathematical content. In some rare instances the coding required some degree of subjectivity; in these cases we used the catalog and a telephone survey follow-up to increase the likelihood of accurate results.

In order to organize the data more coherently, departments were categorized into seven fields: agriculture, business, education, engineering, humanities, science, and social science. This categorization addresses the difficulty of comparing departments with different names as well as the problem of accounting for schools without certain departments.

From the results of the survey, it was estimated that there are 173,237 enrollments in courses that teach advanced mathematics outside of mathematics departments. The 95% confidence interval for the true number of enrollments is $173,237 \pm 28,530$.

TABLES

Distribution of enrollments by school size, school type, and region.

FIELD	SIZE			TOTALS
	LARGE (+10,000)	MEDIUM (3-10,000)	SMALL (-3,000)	
AGRICULTURE	858	0	0	858
BUSINESS	32,419	15,908	341	48,668
ENGINEERING	70,142	10,696	3,016	83,854
SCIENCE	30,292	7,885	1,577	39,754
SOCIAL SCIENCE	59	44	0	103
TOTALS	133,770	34,533	4,935	173,237

FIELD	TYPE				TOTALS
	Public Universities	Public Colleges	Private Universities	Private Colleges	
AGRICULTURE	165	627	66	0	858
BUSINESS	14,857	12,360	9,711	11,741	48,668
ENGINEERING	27,620	35,277	13,651	7,306	83,854
SCIENCE	12,670	16,601	3,821	6,662	39,754
SOCIAL SCIENCE	0	0	103	0	103
TOTALS	55,312	64,865	27,353	25,709	173,237

FIELD	REGION				TOTALS
	EAST	SOUTH	MIDWEST	WEST	
AGRICULTURE	66	165	33	594	858
BUSINESS	18,196	7,742	10,564	12,166	48,668
ENGINEERING	16,960	30,967	16,300	19,627	83,854
SCIENCE	10,569	9,671	14,005	5,509	39,754
SOCIAL SCIENCE	22	0	37	44	103
TOTALS	45,813	48,545	40,939	37,940	173,237

Forum

In response to a recommendation of the Science Policy Committee and action by the Council, *Notices* is instituting with this issue a regular feature called **Forum**, which will publish short articles on issues which are of interest to the mathematical community.

Readers are invited to submit articles for possible inclusion in Forum to:

Notices Forum Editor
American Mathematical Society
Post Office Box 6248
Providence, RI 02940

Articles should be between 1000 and 2500 words long.

We begin **Forum** this month with two articles concerning mathematics education and the professional mathematician by Herb Clemens and Harvey Keynes.

Research Mathematicians and the Education of Children - A Proposal

Herbert Clemens
University of Utah

This article is based on a 20-minute talk by the author in the Special Session on Mathematicians and Educational Reform at the AMS-MAA annual meeting in Louisville, January 18, 1990. Although other mathematicians may be interested in the program proposed in the article, the article itself is addressed to a very restricted audience, namely to those mathematicians, typically in their 30s and 40s, whose energies are directed primarily toward their own mathematical research. The article attempts to find a limited yet very necessary role in elementary and secondary educational reform for some of these mathematicians. In spite of the general tenor of remarks in the January 31 issue of the *Chronicle of Higher Education*, many mathematicians are deeply involved in educational reform at all levels, and there is certainly no intention here of diminishing in any way their very commendable and successful activities. But there

is a role for some of those who, up to this point, have been uninvolved, a role which might have the secondary effect of giving some of the future leaders of the mathematical community some insight into the needs of school mathematics:

There is much talk about the need for reform of mathematics education in the U.S., and there are currently many initiatives for change. However, most mathematical researchers have pretty much stayed out of the reform efforts so far. Many pay lip service, although in their heart of hearts they probably believe that there is not much that they as researchers can do. Maybe they hope that their self-serving "prejudices" could actually be true, namely that the talented ones, those born to do mathematics, will survive most any educational system equally well or poorly, and that those are the ones with whom the future of the subject lies.

Also, we went through this discussion once before in our lifetimes, in the early sixties, when enlightened and mathematically correct reforms, based on curriculum change and led by mathematicians, were adopted. But there were serious political mistakes in that effort, and many would say that things didn't get better.

In any case, these days working research mathematicians with little time to spare are, and probably should be, relatively marginal to the efforts to reform teaching, training, school curricula, etc. Those problems are big, too absorbing, and too political, for those whose fundamental activity is research in the subject itself. These researchers do not have the time or energy to give themselves to programs of educational reform. They often feel that the mathematical community should do something about education, but they are simply not willing to stop doing research in order to take action themselves. So, those not capable of making the "ultimate sacrifice" of stopping their research, what's to be done?

How can they continue their research with the necessary intensity, and yet do something useful? I believe that there is a way to resolve this dilemma, a way that is not contradictory even to those who feel that their responsibility is to preserve, create and enhance school mathematics, and to communicate it to others. In the

I feel that it is with an eye to protecting and cultivating our subject for future generations that we should look for the researcher's principal role in mathematics education.

In this regard, I'd say that there is something essential to the future of our discipline that is perhaps best done by those currently active in research. I feel that at least some researchers can, and must, give a limited amount of time and energy to cultivate the talented young people who can become successful and productive mathematicians. This is a role reserved to mathematicians—as a rule of thumb, you have to do some good mathematics before you can realize what's good and who has talent. And among mathematicians, researchers, especially those who will occupy future roles of leadership in the mathematical community, must play a part, if we are going to attract a new generation to our subject, and thereby insure its future in our society.

To most talented North American young people today, mathematics is simply not beautiful enough, or human enough, to attract them away from other pursuits. Is that primarily our fault? I don't think so—it is as much our culture's fault as it is ours as mathematicians. If we have failed, it is an intellectual failure; we have not created or discovered quantitative knowledge that is beautiful or insightful enough. And it is hard to blame ourselves for our own lack of intelligence—we can only work with the smarts God gave us!

But whether or not we are at fault for the current situation is not the point. The future of our subject in this country is at stake. We cannot build that future on the basis of our ability to buy human talent from abroad, or solely on those whose parents' transplanted values sustain them for one more generation. Not only such a policy not wise in historical terms, it may become practically impossible in the coming decades, if other regions of the world move ahead of the U.S. economically.

So, if doing nothing is not an acceptable alternative, then let's begin to examine what the research community might do.

In the making of the future mathematicians in this country, I don't believe that "enlightened programs" alone change young people very much. Of course, exposure to beautiful mathematics attracted us and it will continue to attract some young people. But another essential source of influence, I think, is contact with our collective intelligence and our aesthetics. And here we fail! We simply do not put ourselves in situations in which we can share those things with a receptive audience. People change people. Right now, the intellectual beauty of our subject and our own intellectual generosity are simply not compelling enough to attract the necessary numbers of those who should come after us. If we haven't the capacity to make more beautiful mathematics for young people, we do have it within our power to be

more generous in sharing the beautiful mathematics that we do have.

For many, especially in our culture, mathematics is more appealing when it is not an isolated, impersonal exercise, but rather an act of quantitative communication which energizes giver and receiver. If many of us are demoralized by the character of our undergraduate teaching in this respect, maybe we are dealing with the wrong group. Maybe by then it is too late in a young person's life to strike the spark. Maybe the practical concerns of adulthood, and a certain amount of unconscious intellectual cynicism have already set in.

I think that the deeper quantitative contact with students is possible, but the natural audience for the deeper kind of mathematical contact I'm talking about is much younger. Our younger children, especially the quantitatively talented ones, are open to mathematical reasoning and are excited by it. Left unaddressed, this interest and excitement soon yields to other compelling influences. It is to this elite group of children of ages roughly 8–12 that we should direct some energy. Now I'm not advocating that mathematical researchers should become part-time grade school teachers. God forbid! Most would be terrible at that! Besides, most kids are not made to be future mathematicians. In the matter of making true intellectual contact with those capable of becoming future mathematicians, and inspiring them, it's only a very small group we should be concerned with. My point is that that small group is not available for most of us at the University level, but that it is available to us if we seek it out. For the future of our profession in this country, some of us must go out there and make contact with it. In this matter, there is just no substitute for personal contact.

So the primary duty of the researcher is to the subject of mathematics. The role of such a small and politically impotent group in the broader question of the quantitative education of society in general is necessarily quite small. But our influence on a future mathematical elite is essential. Therefore I feel that that is where the research group must concentrate the very limited energies it has for social concerns. To do that, we must be ruthless. We must be willing to be called elitist, and correctly so! Our discipline is an elitist discipline—that is in the nature of things, nothing we do or say will change that fundamental fact. So let's recognize it, accept it, and put our social energies where they will do the most good for everybody, namely by cultivating those who can and will preserve and advance our subject in the future.

So let me propose a program in math ed that the AMS and some working research mathematicians should get involved in. This program comes out of my own experiences and those of other mathematicians who have spent some time with school kids in recent years. I would like to propose that the AMS begin a program to

encourage some of its members to spend a little time in a grade school "on their way to work." Such a program might, perhaps, take the following form:

1. Each mathematician-volunteer visits a school 3 times per week, about 1/2 hour per visit, during the course of one academic year, and works with groups of 10 or more children. The goal for the initial two-year period is the participation of 100 mathematicians throughout the U.S.

2. Each mathematician-volunteer gets one-quarter course teaching reduction from his or her home University. (Estimated replacement cost for lost teaching is \$3,000-4,000, of which \$2,500 would be covered by the Program.)

3. AMS submits a proposal to NSF that they give a \$350,000 grant for the first two years of the program: a) \$50,000 for half-time administrator, b) \$25,000 operating budget, c) \$25,000 equipment budget (to set up an "all email" correspondence system and assemble useful materials), d) \$250,000 to pay replacement costs to participating Universities for a total of 100 quarter-course replacements.

4. AMS asks NCTM to locate potential participating school districts. Universities and individual mathematicians wishing to participate go through the NCTM or local contacts to line up a host school.

5. AMS asks NCTM to locate in each participating school a host teacher who serves as the facilitator for the interaction between the mathematician and the school kids. The host teacher also screens the mathematician to insure his or her suitability for participation in the Program, and chooses the children who should participate, and familiarizes the mathematician with NCTM guidelines for math learning and with the math program at the host teacher's school.

6. To the question "What do I do when I'm sitting around for half an hour with a dozen fourth-graders?", the first quick answer is "Whatever the regular fourth grade teacher suggests." The mathematical conversation usually begins with what the kids are doing in their regular math class. If this collective conversation lags, or local resources are insufficient, an email "hotline" to a library with a resource person and some good materials should help.

7. The short-term goal is to make early contact with mathematical potential; the long term goal is to locate and encourage future mathematicians in order to maintain the health of our profession.

For many researchers, the need to do something is compelling, but the limitations on their time and energies are compelling too. The above is one suggestion of a way that some can involve themselves meaningfully, expending little more time than it takes to read the morning paper. For some of us who have tried it, the experience has been surprisingly satisfying.

Finally, let's talk politics. If we as mathematicians spend a little time with some bright young kids, we may make real intellectual contact with a few of them. But there is another reason for spending a little time even if we don't succeed in making that contact. Just being around some schoolkids every so often makes an important political statement to a far wider audience. It is the statement that who those kids are and what those kids do is important to mathematicians, and to the future of our subject. The statement is true, so let's say it.

Can Mathematicians Be Involved in Education and Still Survive in the Profession?

Harvey B. Keynes

University of Minnesota

I. The Issues

Mathematics education is undergoing intensive examination at all levels, and major reforms in curriculum and direction are now in the process of being implemented. The need for mathematicians to be extensively involved in these endeavors has been widely recognized. A few have organized major innovative projects in teacher training, networking for curricular reform, and innovative programs for underrepresented groups and gifted students. Yet for the most part, mathematicians are ignoring these educational opportunities, and avoiding any real level of involvement. Despite excellent educational funding opportunities at a time when research support is declining, and constant pleas for increased involvement from university, government, and business leaders, academic mathematicians are clearly questioning whether their participation can be part of their professional activities. We need to examine and question some of the reasons for their hesitancy and change many of the perceptions if we hope to raise the educational involvement of the mathematics community.

At the heart of the issue is the belief that educational issues, concerns about teaching, and involvement in school curriculum are really not matters that are professionally attractive to most university and college faculty. One program officer at NSF described the typical reaction from chairs and senior faculty at all levels of universities to be that while education and teaching are important for faculty at schools which should emphasize undergraduate education, their own school is primarily interested in research. This attitude is even seen into some of the best small colleges, where emphasis on providing undergraduate research opportunities and competition for faculty have led to increased interest in faculty research, especially for younger faculty. So, usually all of the leading universities and colleges disengage involvement in K-12 mathematics education in the name of research.

of various research activities. The deeply held conviction that research interests and educational involvement are incompatible continually permeates discussions on these matters. In fact, most mathematicians generally believe that involvement in educational activities at any level is a sign of disinterest or incapability in research activities. All too often, a faculty member who has lost interest in research and scholarship activities is described as automatically being interested in teaching and education. Even the few mathematicians with significant educational interests and research activities frequently feel the stigma of being viewed as less dedicated and valuable than colleagues with only research activities. We must examine ways to change this attitude of our colleagues and peers if we expect to see more mathematicians considering educational involvement.

Closely related to this view of education is the perception (and in most cases the reality) of the reward system in our profession. In discussions with younger full professors who may be more willing to consider educational involvement, their opinion of the reward system in mathematics is a major deterrent to their participation. They believe that even significant and highly successful efforts in education will not provide merit salary increases and other professional respect and opportunities. Despite lip service to the contrary, this is the reality in many departments. In a recent essay on mathematics education, Bill Thurston states "What needs to change urgently is not so much the system of advice, of teacher training or of mentoring, as the system of professional rewards." In a few departments where such activities are rewarded, chairmen need to keep these considerations virtually secret for fear of disapproval among the senior staff. Some highly respected mathematicians would find it unacceptable if anything other than a theorem or an outside offer was to play a role in a merit increase. Various presidents, provosts and deans publicly lament how faculty are not involved in educational activities, yet seem to be unwilling to take on the conventional wisdom and advocate changes in the reward system.

So the impediments to more involvement in education are clear: professional respect among colleagues and peers, and professional rewards. Since the forces to change these issues reside primarily in our mathematics community, we need to address ways to influence our departments and professional societies.

2. What Can We Do?

The key to any lasting reform will be changes in professional attitudes of most mathematicians. This does not mean that very many will change their professional goals or their personal value systems. What it does mean is that professional tolerance for colleagues who want to become involved in education should be encouraged at

all levels in our community, and professional rewards for high quality, successful and significant activities become embedded in the system. An important aspect is not to trivialize a good educational project as any non-routine activity outside of research. The efforts required to organize and implement a multi-year educational project can be enormous and the chances for no real success can be quite high. Education is unlike traditional mathematical research, and more like many experimental sciences. It is frequently not the conception of the project, but the enormous organizational and administrative efforts, together with sensitivity to classroom cultures in the context of mathematics content, that makes for successful educational programs. While these efforts may be intellectually less challenging than standard research, the emotional, physical and organizational strain are usually far more intense. We need to respect these levels of involvement, and reward those faculty that meet high standards similar to those of good research.

An important aspect of providing high-quality professional involvement in mathematics education is to encourage participation when personal circumstances are right. Many active researchers might find a particular educational program appealing, and wish to be involved for a short period or even a few years. Because of fresh ideas and higher levels of enthusiasm, the involvement of research mathematicians is critical to both new and established programs. Many times, a reasonable research program is maintained during this initial involvement, and in some cases, a new professional balance between research and education is reached. We should encourage these elective shifts of emphasis. In the context of maintaining an appropriate research and scholarly program for their department, younger faculty could be encouraged to have some exposure to educational activities. There are sufficient numbers of senior mathematicians who are re-examining their professional directions so that without really compromising tenure and promotion standards, significant educational activities could still take place. For certain senior mathematics faculty, professional respect for educational issues might encourage them to seek new and productive involvements in education when their research activities have peaked. With the current demographics of the community, this could provide a growing source of mathematicians to meet the escalating needs in education.

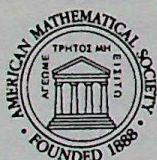
Which organizations are best equipped to influence these changes? Because the heart of the problem resides in the attitudes of research mathematicians, our research societies must play a leading role. The AMS is seriously beginning to examine its role in education. Discussions at the 1990 meeting in Louisville could set the tone for a significant official level of recognition of educational activities. SIAM has also maintained a serious interest in education, and would likely support any new AMS

position. The MAA has always maintained its own educational agenda, and their excellent ongoing efforts would clearly support and supplement any changes within AMS and SIAM. Finally, the Mathematical Sciences Education Board (MSEB) and the NSF-funded Mathematicians and Education Reform Network (MER) can play appropriate advocacy roles for shifts in educational interests within the mathematics community. But the real change must take place within the rank-and-file of the mathematics profession, most specifically among the academic research mathematicians. This will clearly be a long-term project, with many dissenting voices and calls for historical standards. Such debate is healthy, and perhaps should take place in our professional journals and at professional meetings. Some courageous department heads and deans should take the initial steps in changing the reward systems at their schools, and begin the process of professionally integrating educational activities into the life of their mathematics departments. Most importantly, we need the research leaders in our community to actively support these new roles in mathematics education, and be willing to challenge other leaders with less tolerance.

3. Some Final Observations

Especially in academic environments, mathematicians have historically juggled two aspects of their professional lives - their personal esthetics and research interests on one side, and their educational and service components

on the other side. The balance is always shifting, but in the post-Sputnik years moved heavily towards the research end. We currently have a culture that is generally comfortable with this role, and has built a professional structure to support it. But recent changes in our society now question the wisdom of the mathematical community to continue to accept the current balance. Among these is the widespread recognition that the need to reform the K-12 mathematics curriculum necessitates the involvement of mathematicians at all levels to help develop alternate approaches and curriculum. Undergraduate and even graduate mathematics curriculum is also under careful review and revision. Because of the central role of mathematics in our changing society, mathematics and mathematicians are now linked to two central concerns of our society - economic competitiveness and human resources. Future resource allocations to all sciences, including mathematics, will probably be heavily dependent on the country's perception of how effectively they contribute to the improvements of these essential areas. To insure the vitality of our profession and to maintain attractive professional rewards, we as a community need to shift the professional balance at this time and re-affirm our interest in educational activities. We need to electively make this change within our own professional culture, and truly support our peers and colleagues who engage in high quality and exciting educational programs.



UNFOLDINGS AND BIFURCATIONS OF QUASI-PERIODIC TORI

H. W. Broer, B. Huitema, F. Takens, and B. L. J. Braaksma
(Memoirs of the AMS, Number 421)

In the theory of dynamical systems, the occurrence of equilibria and periodic motions, as well as their general persistence and stability properties, are now fairly well understood. Researchers also have some systematic insight into the role of external parameters. This book aims to mimic this classical theory in the case of quasi-periodic motions. These motions are most familiar in the context of the conservative dynamics of classical mechanics, but they also occur with dissipative dynamics—for example, quasi-periodic attractors play a role in the onset of turbulence.

In the first part of the book, the authors present a general treatment of the use of external parameters in various contexts, employing notions such as integrability and transversality. The second part, dealing only with dissipative cases, studies bifurcations when the hyperbolicity is mildly violated. Readers will appreciate the way the book systematically ties together a number of cases for quasi-periodicity and the resulting improvement of accuracy. In addition, a number of new applications are presented.

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Computers and Mathematics

Edited by Jon Barwise

Editorial notes

Are good research tools good teaching tools?

In last month's column, Phil Miles wrote an article about the use of *Derive* in pre-calculus classes. He raised an important question: Does the use of such a program help or hinder our students' understanding of mathematical ideas?

Let's be clear what is at issue. Few doubt that students coming out of mathematics courses need to have a basic understanding of the computational tools that are available, and how one would use them. Nor was Miles questioning whether the computer can be an aid in teaching. His worry was whether computer algebra systems help teach the basic ideas of mathematics.

Several years ago I overheard some students, looking at a returned calculus midterm, complaining about the rules of exponentiation. They thought the rules very unnatural. In particular, one said "Mathematicians are really perverse to set up a rule like

$$x^n x^m = x^{n+m}$$

rather than the more sensible rule ... " where you would multiply exponents. His friend agreed.

What is disturbing about this conversation is not the error itself, but the view of mathematics that the conversation demonstrates. Would the use of a computer algebra system alleviate or exacerbate the problem? No doubt the answer depends on the system and how it is incorporated into the teaching. Miles observation is that there is a danger that these systems *could* make things worse, not better, by making mathematics look even more like a formal game with arbitrary rules.

The issue of what goes to make up good courseware for undergraduate mathematics is addressed in an article by Keith Devlin in this month's column. Doug Child, one of the developers of one of the programs discussed, takes issue in a follow-up. Further discussion is welcomed.

Computer Algebra Systems Workshops

Speaking of the use of computer algebra systems in teaching, the National Science Foundation is sponsoring a number of CAS Workshops. Here is a list of those coming up soon.

- June 18-22, 1990: Mississippi State University, P.O. Drawer, MS 39762. Contact Jimmy Solomon at MSU.
- July 15-20, 1990: Colby College, ME 04901. Contact Don Small at Colby College.
- July 22-27, 1990: Colby College, ME 04901. Contact Don Small at Colby College.

Computers in research

This column is still anxious to get articles reporting on the use of computers in mathematical research, as well as articles on the mathematics of computation. Submissions should be of about 3-5 pages in length, and informal in nature. Send them to:

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After July 1, send it to me at my new affiliation:

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This month's column

In addition to the article by Devlin, this month's column contains short reviews of several pieces of mathematical software: *FFTLIB* by PC Scientific, *Phaser*, and three programs for the NeXT: *Groups*, *Rubik Algebra* and *Orbit*.

The Right Stuff

*Keith Devlin**

The right stuff: small or large?

It is now almost an axiom that the use of computers in college-level teaching is A GOOD THING. After all, the students we produce will go out into a world dominated by their use. But what about the use of computers in college *mathematics* teaching? There too it seems a sensible move. Like the pocket calculator of yesterday and the slide-rule before that, the arrival of the readily available electronic computer has changed for ever the manner in

*Dr. Keith Devlin is Carter Professor of Mathematics and Chairman of the Mathematics Department at Colby College, Waterville, Maine 04901. His email address is devlin@colby.UUCP.

which large parts of mathematics are developed and used *in the world* (setting aside research uses in university mathematics departments). The mathematics we teach, and the way we teach it, should certainly reflect those changes.

But what makes a piece of mathematics software suitable for classroom use at the college level? It depends, I believe, on the nature of the course and on the level. Features that would make a particular package an ideal tool to use in an upper-level class might make it quite inappropriate for use with freshmen.

In particular, a recent in-house workshop in computer use in mathematics teaching at my own college (Colby College in Maine), led to the conclusion that all-purpose computer algebra systems (*Maple*, *Mathematica*, *Calculus T/L*) have obvious uses for teaching upper-level courses to mathematics majors, but several major drawbacks as far as freshman-level instruction is concerned, especially for classes made up of students whose interest in mathematics is either peripheral or utilitarian. For lower-level courses, small, special-purpose packages seem to be far more useful.

I should add that the above is my own conclusion, and likewise the views expressed in the remainder of this article are my own. They do not constitute a consensus view, carefully distilled from the reactions of each faculty member at Colby. It is not, however, a completely 'blind' response. First of all, everything I say is in the light of what I learned and observed over the three days of our workshop. Secondly, my own research work in mathematics over recent years has involved my looking very closely at issues of artificial intelligence, software design, cognitive science, and linguistics. And for the past seven years I have frequently reviewed software in connection with a regular mathematics and computing column I write for *The Manchester Guardian*.

One thing that should be made clear at the outset is that Colby is particularly well-equipped with computers. Besides the three central Vax 'mainframe' facilities and a small number of Sun workstations, the campus is awash with Macintoshes. At the moment, roughly one-in-three students purchase their own Mac at a discount from the campus bookstore, and the goal is for all students to have their own computer. Plans exist for every dormitory eventually to be wired into the campus Ethernet. The standard equipment currently being provided for faculty in the mathematics department is a 5Mg/80Mg MacIIcx with a color monitor. Outside my office is a student computer laboratory containing 17 similar machines. There are three Laserwriter IINT printers, one for faculty, the other two in the computer laboratory. All machines, office and laboratory, are connected to the campus network and to two central Macintosh file servers.

Software used by almost everyone on campus includes Microsoft Excel, Microsoft Word, and MacDraw.

Available in the mathematics computer laboratory are *Mathematica*, *Maple*, and various statistics packages, together with a host of other software. The use of TeX and L^AT_EX to prepare mathematical papers and student exams is becoming increasingly common.

The right hardware

First, some comments about the hardware. (For reasons that should become clear, I do not regard this as a side-issue to this review.)

The Macintosh computer, and especially the 5Mg MacIIcx with a color monitor that we have in our computer laboratory, is a very powerful teaching tool, both for classroom demonstration using a screen projector (we have two of these for our teaching at Colby), and for individual (or even better, student-pair) use. It is fast, robust, easy to use, and user-friendly to the point of a love affair. (I have seen this level of attachment in well over half the Macintosh users I know, and I know many.)

The Mac came upon the world so rapidly that I suspect a great many people still do not realize what a truly huge step forward it was. Quite simply, it revolutionized computing. Indeed, given what preceded it, it is highly misleading to continue to call it a computer. From the user's point of view, it is something quite different. "desktop friend and assistant" is the only phrase I can think of that conveys something of what it represents. To think of it in terms of a powerful von Neumann computer with a fancy graphics interface is to completely miss the point, analogous to the early description of the motor car as a 'horseless carriage.' (Though that particular example should indicate just how pervasive can be the tendency to fail to appreciate the scope of a truly revolutionary development.)

So what is it that singles out the Macintosh (and should by now be clear that I am talking about the system as encountered by the ordinary user, not the hardware inside the case)?

For one thing, the fact that once you have learned to use one Macintosh application, you can easily use any other. Just as learning how to drive one kind of car equips you to drive any other car, with only minor adjustments.

For another, learning how to use that first application (whatever it is) is extremely easy. By and large, once you know about mousing and pulldown menus, the general rule is that the 'obvious' thing to do next almost invariably turns out to be the correct move. And if by some chance it is not, the system is forgiving and allows you to try again before any serious damage is done (as with your accidentally erasing the entire hard-disk).

And it is fast and responsive (at least when you get into the realms of 5Mg IIcx's). A bit like driving a Buick but with the expansive comfort of a Buick.

But most of all, it is fun. Given the right software, I have yet to see anyone who does not get 'hooked' by the beast.

The Colby in-house workshop

Now to the software. Finding out about this was not too difficult. Colby has a national reputation for investigating the use of computers in teaching. This stems largely through the work of Don Small, the current director of the NSF "Computer Algebra System (CAS) Workshop" program, presently finishing a book with John Hosack on the use of CAS's in calculus teaching (to appear with McGraw-Hill later this year). In addition to Don's work, two of the faculty, Dale Skrien and Bruce Frech, have developed their own teaching software for the Macintosh. (And prior to my arrival at Colby last year, I was in the computer-rich environment of Stanford.)

But as is so often the case, practically all of this work has been done on an individual basis. At no stage was a decision made that the department should "go for computers." It just happened, quite naturally.

When I arrived as chairman at Colby, I was excited by all the activity going on around me, but unsure as to just what was being done. So I asked Don Small to organize a small workshop for ourselves this last January.

The basic format was: three days; hands on experience interspersed with classroom instruction and discussion; pizza dinners together on two nights followed by a discussion of what had been done during the day. In addition to us all becoming familiar with the two large packages used in some Colby calculus courses, I wanted each faculty member who made regular use of a certain piece of software in their classes to demonstrate it to the rest. The workshop was small and intimate. Our faculty consists of ten people. (A typical CAS workshop will have twenty or so participants.)

Thus in both format and size, our workshop was not quite the same as a typical NSF CAS workshop. Likewise the intention and expected outcome were not. By their very nature, CAS workshops attract those who either are, or else very much want to become, involved in the use of CAS's in their teaching. The participants in our workshop ranged from the strongly committed and highly experienced computer users to the skeptical computer novices who hardly ever use a computer either for teaching or for anything else. Apart from Don Small, none of us were familiar with CAS's.

One problem that concerned me before we started was that the results that had been observed at Colby, as far as computer-based freshman calculus instruction was concerned, were highly inconsistent. Some students would emerge from such a course saying they had got a lot out of it, but there were others who came out of it totally turned off mathematics, if indeed they came

out of it at all. Such experiences are not uncommon, as far as I can tell from talking to other colleges that have tried computer-based calculus instruction, but as department chairman at a small (1600 students), private, highly-selective (expensive) liberal arts college, this was obviously a worry. Though we only graduate about 10 or 12 mathematics majors each year, some 300 or so students annually pass through our freshman calculus teaching program. Only a small fraction (about 10%) of this total was put into the computer-based courses, which we still regard as under development. By and large these were amongst our better student entry.

Computer algebra systems

Let me start with what for me was the bad news, and what I think is one major factor behind the wide range of responses to our CAS-assisted calculus courses. Hitherto, these have been structured around *Maple* and *Calculus T/L*. Well, I do not think *Maple* is particularly well-suited to freshman-level calculus teaching. And *Calculus T/L* strikes me as a disaster.

I hasten to repeat that these are my own opinions. They are offered in a constructive spirit, as part of the on-going development process of such systems. *Maple* is a very powerful research tool, and I can see it being a useful aid in higher-level mathematics courses involving a lot of student investigation. And it is only by developing and examining the use of systems such as *T/L* (which is designed as a calculus teaching tool—the mnemonic "T/L" stands for "Teach and Learn") that we shall be able to make progress. So I wholeheartedly support anyone who sets out to develop any such system, and would applaud their efforts. These are early days of trial and error.

The version of *T/L* we had available had so many faults, it is hard to know where to begin. (We had a pre-sale issue of Version 1.0, which Don told us is "very close" to the version that Brooks/Cole will be bringing out later this year.)

Calculus T/L sits on top of *Maple*, which means that one is already far removed from the power and elegance of the Macintosh graphical interface, and boy does this show. Switching from an operation in one window to one in another requires a clumsy two (separate) mouse clicks. The menu layout within each window is not at all easy to master. The main instruction method is the familiar "programmed learning" routine that did not work when it was presented in books and does not work very much better on the computer screen. The more so since this part of the program occupies a small, paged window at the top of the screen, which means that one is continually having to click forward and backwards from one page to another. The result of all this to-ing and fro-ing is that one very quickly gets lost, and with

the loss of location comes the loss of the logic of the argument, loss of the mathematics being presented, and soon after that plain loss of interest. It took two of us, both professors of mathematics with many years of experience behind us, and both computer literate with a great deal of Macintosh expertise, several increasingly frustrating attempts to follow a simple presentation of the trapezoidal rule, and even when we had obtained an answer, it took a lot of effort to figure out what the output meant.

Figure 1 is a print-out of the screen display we obtained. There was no additional explanation. What you see is what we got. As you will (might?) see, we were trying to integrate $\sin x$ from 0 to π using the trapezoidal rule with 8 subdivisions. Neither of the two graphs we obtained was of the function we were integrating. The second derivative was evaluated and graphed, and we were presumably expected to use this to figure out the degree of error we were prepared to tolerate, but despite being shown this part of the procedure by someone familiar with the program, we were unable to reconstruct this step ourselves, and so chose an error bound 'arbitrarily', thereby sidestepping the most critical part of the entire process.

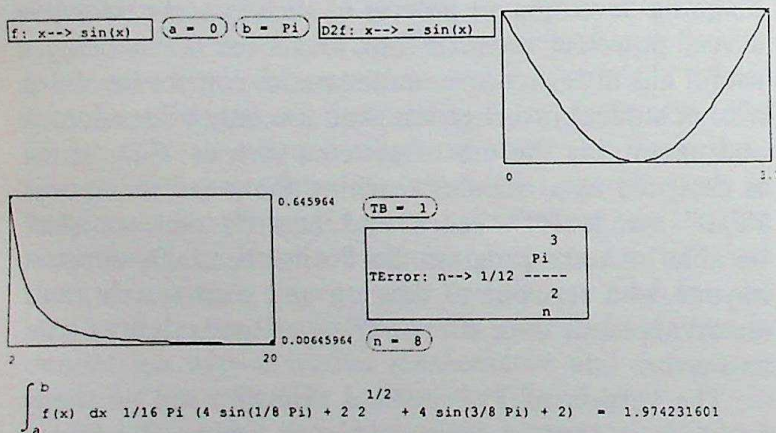


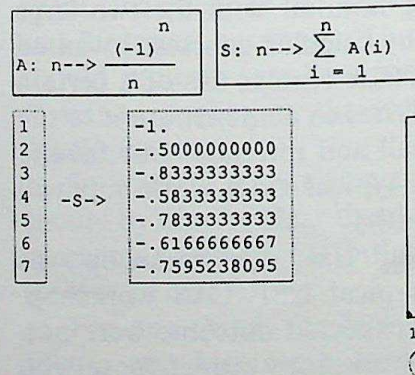
Figure 1. Calculus T/L. Use of the trapezium rule to evaluate the integral of $\sin x$ from 0 to π .

Being smart, *Maple* (which presumably performed the actual calculation) realized that we were integrating a function that was symmetric over the range of integration, and collapsed the trapezoidal sum. Thus the final expression contained only four terms instead of the expected eight, which would doubtless confuse the beginner trying to master the trapezoidal rule. And after a lot of thought we finally decided that the mysterious hanging $1/2$ in the middle of the expression was an exponent on the 2 beneath it, so that the middle term was in fact $2\sqrt{2}$ (this being the same as $4/\sqrt{2}$). How did we figure this out? Well, because we were very familiar with the trapezoidal rule, familiar with the behavior of symmetric functions, and had enough experience with computers (though not computer algebra systems themselves) to have a pretty good idea how they would perform their

symbolic computations. But this package, remember, is supposed to explain the trapezoidal rule to beginning calculus students.

Other complaints. Well, given the level of sophistication of present day Macintosh graphics, there really is no excuse for putting out a teaching program that uses two disjointed minus signs and a greater-than sign for a function arrow, the word 'Pi' for the constant π , a freely hanging $1/2$ to denote a square root, and the kind of misleadingly clumsy and just plain ugly boxed expressions shown in Figure 1 for the error function. (Incidentally, it was left to the user to guess what n denoted, and likewise a and b , though I suppose even a beginning student should be able to guess this correctly.)

Following our disastrous experience with the trapezoidal rule, my colleague and I turned to summing infinite series. Figure 2 shows what we got. Again there were all the problems mentioned above concerning the small, paged instruction window at the top of the screen and the appalling screen display, with the word 'infinity' instead of the readily available (in a Macintosh font) ∞ symbol, and the wandering limits of summation that only make sense to one already familiar with summation in the first place. Also, there was considerable variation between the manner in which integration and series summation were handled pedagogically, which tended to obscure the similarities between the two processes. But what appalled us most of all was the response we got when we set the program to work on the alternating harmonic series.



$\lim_{n \rightarrow \text{infinity}} S(n) = \text{undefined}$

Figure 2. Calculus T/L. Summation of the alternating harmonic series.

First of all there was a mysterious "j" that kept increasing by factors of 2 every time we asked for a longer partial sum. We eventually figured out that it was the number of terms summed, but the way this appeared obscured this from us for some time. Admittedly, we did not have a program manual at hand. After a brief explanation and demonstration of the program by Dr. Small, we simply sat down and started to use the program. But as I argue below, that is exactly

is required of good educational software aimed at the beginning student. Moreover, this is exactly what the Macintosh system is designed to provide, and not to take full advantage of it is to waste an extremely valuable resource.

But far, far worse than the mysterious "j" was the graph of the partial sums of our series. You will notice from Figure 2 that these form a monotone increasing sequence. For the *alternating* harmonic series? Are you kidding?

Of course, what has happened is that only every second partial sum has been plotted. Now *you* know that, and so do I. We also know that the partial sums of this particular series *oscillate*! But what about the poor freshman student struggling to grasp the notoriously difficult concepts of sequences, series, convergence, and all the rest? To display a graph that hides the crucial factor about the alternating harmonic series that makes it converge, namely the oscillations of the partial sums about a limit-point, is inexcusable. And then to cap it all, *Maple* (I presume it was *Maple* this time) told us that the series did not converge, when the one thing the graph *did* indicate was a pretty clear case of convergence!

At this point, my colleague and I gave up in confusion and dismay.

But enough, surely, is enough. You get the picture. So let me repeat that I am not at all opposed to people striving to incorporate computer use into their teaching. Since the graduates we produce will be seeking employment in a world dominated by computers, we would be negligent if we did not do this. But for heavens sake let us take full advantage of the technology available. There is simply no need to put on the market a package that has so many faults as does *Calculus T/L*.

As I understand it, *Calculus T/L* is largely the work of just one person, a mathematician. I applaud his effort and the motivation that lays behind it. But please, sir, don't let this get into the hands of beginning students.

Good educational software is very valuable. It is also very costly. Except for the simplest of programs (and maybe even then), it can only be produced by a team effort, involving mathematicians, mathematical educationalists, educational psychologists, professional designers, and experienced software writers expert with the chosen machine. You would not entrust your child's operation to a single doctor working in his living room. You would expect a highly trained team having all the facilities they required. Likewise with your child's education.

But enough about *T/L*. The good news is that once you get away from those large, catch-all, CAS-type systems, there are some really nice packages about. Before I tell you about the ones we looked at, let me tell you what, in general terms, I think makes them useful.

What makes for good software?

The Macintosh system offers such enormous potential for introductory-level mathematics teaching, it seems to me imperative that we take full advantage of its various features and its capabilities. Good software should stay close to the original Macintosh concept, making full use of the Macintosh system. The user should not have to enter lines of syntactically exact code as she does with *Maple*. Good grief, there are even those pesky semicolons to worry about! (I am talking of the user of a freshman learning package now. For many advanced uses, more standard programming paradigms are both reasonable if not downright desirable.) The screen display should be as close as possible in appearance to what appears in mathematical textbooks. The program should be easy to learn, *without instruction*, for anyone with a modest familiarity with Macintosh operation. Attention should be paid to the presentation of material *within the Macintosh framework*. (The matrix package described below is a wonderful example of how to take advantage of Macintosh windows.) The program should be robust. (Students rarely do the things expected of them. Neither do their instructors for that matter!) The program should be written with the knowledge that it is to be used by a human being, and that, of the human/computer pair, the human is the one with the intelligence and the ability to reason and make decisions, the computer is the one with the calculating and information processing speed and the reliability. And, most important of all, the program should be *transparent*. The student should spend her time thinking about the *mathematics*, not how to operate the computer.

So what then did we see during our workshop that so impressed me (and all my colleagues)?

Matrix Works

Well, the first of these was a program written by Dale Skrien, a Colby faculty member. Called *Matrix Works*, this package is designed for performing matrix arithmetic. The entire program is menu driven, and highly visual. Rather than figuring out some fancy method for displaying arrays and brackets on the screen, Skrien did the smart (but perhaps not obvious until you see it) thing, and used the Macintosh windowing system for his matrices. Each window is a matrix. A menu command allows you to specify, for each window you open up, what size of matrix that window should represent. The name of the matrix appears in the window title bar. There are default matrix names supplied with each new window. You can move matrices about on the screen using the mouse in the usual way, so you can position them side by side before you (say) add them together, thereby seeing at a glance if you are trying to add two incompatible

matrices. All the usual matrix operations are available on the pulldown menus. The transpose of a matrix A is denoted by $A \uparrow T$, the inverse of A by $A \uparrow -1$. (A commercially available version ought to replace these by A^T and A^{-1} , of course.) The solution vector to a system $AX = B$ is named $\text{sol}[AX = B]$. And so on. In each case, the user is free to rename a matrix at any stage, and the system makes all the necessary future naming changes this implies.

Figure 3 shows a screen dump of a typical session with *Matrix Works*. (Actually, we tidied it up a bit for clarity. But then, this is something that is easy to do with such a system.)

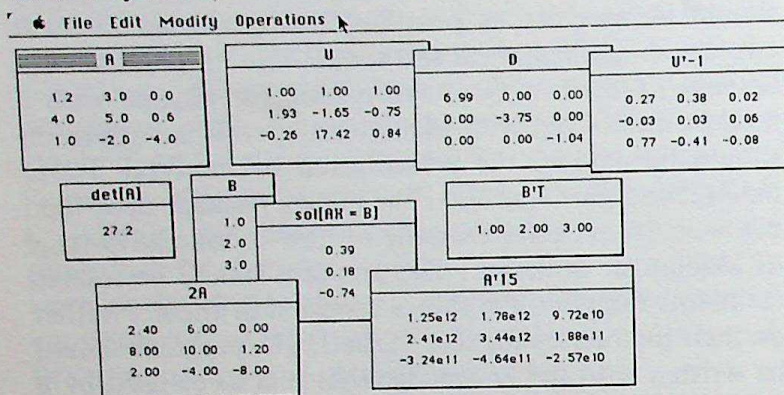


Figure 3. *Matrixworks*. A simple, menu-driven, window-based matrix arithmetic program.

Certainly one can think of ways to improve this program. A menu-available routine for truncating or rounding output matrix entries would be useful. So too would be a symbolic mode. (The present version of the program is purely arithmetic, though it does allow for scientific notation.) But as it stands, it is a shining example of good Macintosh software. The Macintosh-familiar user needs only one instruction in order to become an expert user of this program: *that each window represents a single matrix*. The rest works just as you would imagine. No need for a manual or an extensive help facility. No need for an instructor standing at your shoulder all the time.

DEGraph

The next program that was demonstrated for us was *DE-Graph*, written by Henry Pinkham of Columbia University. This is designed to provide graphical representation of differential equations, together with routines for their numerical solution. Figure 4 (See next page) shows one output from this program. What you see is the vector field (shown using small arrows) for the solutions to the equation

$$y' = \sin(xy)$$

together with a family of particular solutions. The program also allows for the representation of time-dependent differential equations, such as the undamped pendulum:

$$\ddot{x} = -\sin y, \quad \dot{y} = x$$

shown in Figure 5 (See next page).

Our introduction to this particular package illustrates what good software can be like. Our instructor (who had used this program in his sophomore level differential equations course) asked us to open the program the usual way, and began to explain how it was used. Within five minutes at the most, *no one in the room was paying any attention to what he was saying*, and he eventually sat down. Everyone was too engrossed in investigating various of the dozen or so menu-available sample differential equations supplied with the program (all well-known examples from physics). Apparently our instructor had had a similar experience when he used the program in class. His role rapidly changed from being teacher to helper and answerer of the many questions that the students came up with. Interest-driven, explorative learning from the first moment. Great.

Stella

Finally, let me tell you about one further program. (We did in fact look at several others. As I said at the outset, Colby faculty have been particularly active in introducing computers in the classroom.) This was *Stella*, from Dartmouth College. This program shares all the features of ease-of-use and robustness enjoyed by the others we saw, though the only copy we had was virus-infested and, being write-protected, we could not clean it up, so we had to run it (with care and much disinfectant afterwards) off the floppy disk, which probably slowed it down a bit, but not enough to notice for the example we gave it.

Stella is designed to help with mathematical modeling of real-world phenomena in terms of differential equations. It forces the student to adopt a dynamical logic-oriented approach to the problem, by requiring the principal input in terms of a flow chart, as shown in Figure 6 (See page 424). This particular flowchart (which the user enters using the mouse and a small palette of MacDraw-like symbols in the obvious way) models the growth of an infection in a closed community. There are three groups of subjects, those susceptible to the infection, who do not yet have it, those infected, and those immune (this latter category could include those who have already died as a result of the infection). Passage from one category to another (which is particularly simple in this example, but could involve far more complex flow-line dependencies are indicated by means of arrows. The presence of arrows in the diagram, we see that the rate of infection depends upon both the number of susceptibles and the number of infectives. The precise relationships are entered by hand on a standard Macintosh-style questionnaire.

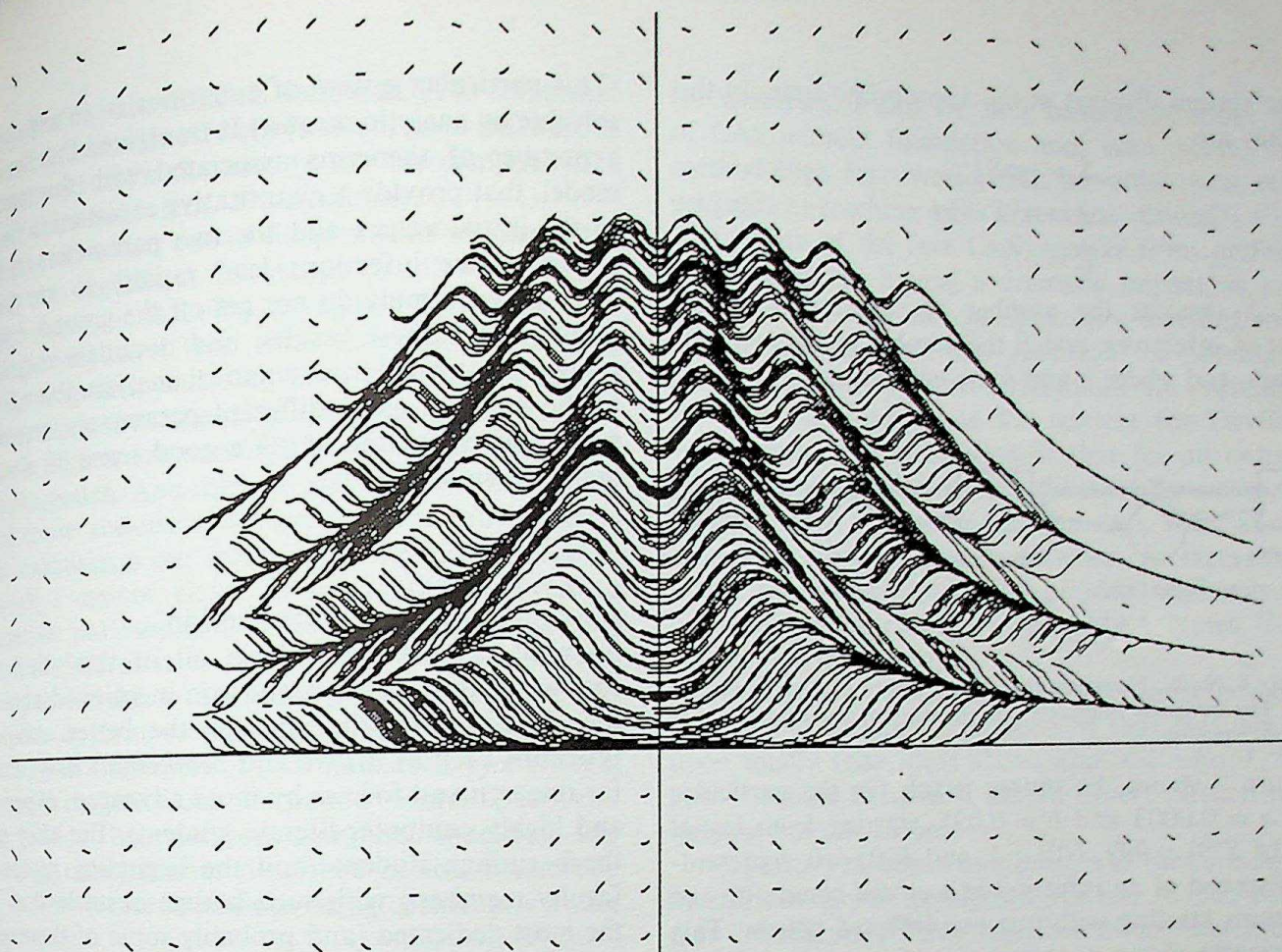


Figure 4. *DEGraph*. Vector field and a family of particular solutions to the differential equation $y' = \sin(xy)$.

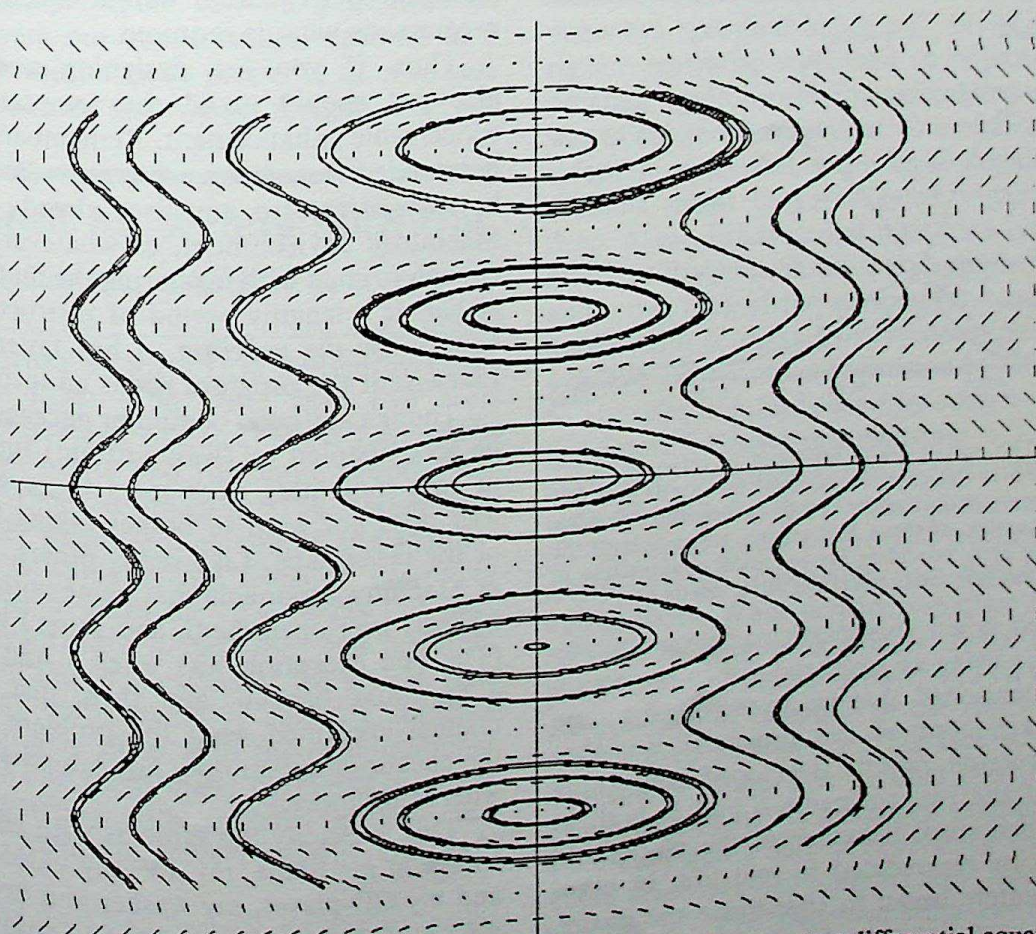


Figure 5. *DEGraph*. Vector field and some particular solutions to a time-dependent differential equation in two dependent variables.

that the system displays at the appropriate time. In this case, they are

$$\dot{S} = -aSI$$

$$\dot{I} = aSI - bI$$

$$\dot{R} = bI$$

(where S denotes the number of susceptibles, I the number of infectives, and R the number of 'removed' or immunes, and where a and b are constants).

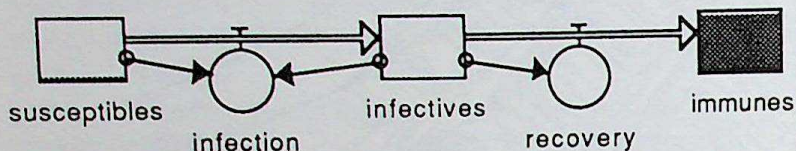


Figure 6. *Stella*. Flowchart depicting the spread of an infectious disease. The program interprets this mouse entered diagram as a differential equation.

Figure 7 shows the output graph for the particular values $a = 0.0003$ and $b = 0.095$, starting from initial values of $S(0) = 999$, $I(0) = 1$, and $R(0) = 0$, representing the spread of an infection in a closed community of 1,000 souls starting with just one infected person. This graph clearly shows a pattern familiar to all those on college campuses during the winter colds and flu season.

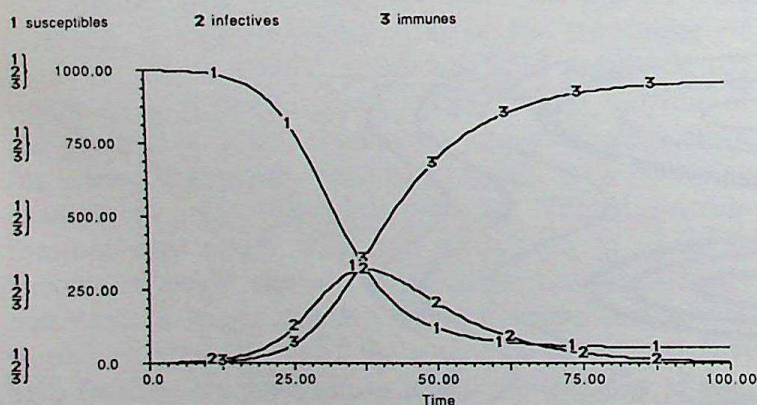


Figure 7. *Stella*. The output graph produced in response to the model shown in Figure 6. In this case, the infection reaches its peak just over thirty days after being introduced by a single carrier, and thereafter tails off, though the number of those that remain susceptible to the disease does not fall to zero, providing mathematical confirmation to the oft-observed fact that infections rarely die out altogether.

What happened when this particular program was demonstrated to us using an overhead screen-projection (I have already mentioned that we were forced to use just one, disk-locked copy of this program), was that a fascinating discussion rapidly developed concerning the significance of the two constants a and b , both in terms of the mathematical behavior of the model and what these constants represented in real life. In other words, we immediately began to investigate the *model*, without getting bogged down in details of the calculus.

(This particular system of equations is, in any case, not solvable by analytic means.) It transpired that there were a number of theorems associated with this particular model, that provide a quantitative explanation (in terms of the initial values and the two parameters, a and b) of why some infections lead rapidly to an epidemic while others simply do not get off the ground. I was not familiar with these results, and doubtless they involve some sophisticated mathematical analysis. But a few runs of the program using different parameters were all that was required for me to get a good sense of what these theorems said.

Conclusion

So what can we learn from all of this? Besides the specific issues of design and use mentioned above, just this: The simpler the package the better. All-purpose programs such as *Maple* and *Mathematica* are excellent for research and for use by more advanced, experienced, and highly computer-literate students. But they present the beginning student (and the beginning mathematics faculty member!) with such a huge obstacle that all but the most dedicated (and probably some of them as well) fall by the wayside. Rather a toolbox of small, independent, user-friendly, well-designed, attractive, robust programs is what is required.

Thus, if you are designing a computer teaching aid, you should avoid the temptation to add every conceivable enhancement. Remember that your program is intended for use by a *beginner*. Your program should be *transparent* (to any user already familiar with the Macintosh environment, or whatever). The student has enough to cope with mastering the mathematics we throw at her. If a lengthy period of instruction is required *how to use the program*, it has failed before it begins. Likewise if the program needs an instruction manual.

Though any good computer package should, of course, be accompanied by (well-written!) full instructions, just in case something does seem to go wrong, the average user does not want to bother taking this document out of the cellophane. Like many others, I have a tall stack of Macintosh manuals that came with my machine. I hardly ever open them, and some I have never opened. (The one exception was when I had problems making a hard-disk backup, and then, just as it should, the manual explained what the problem was, namely that the backup program does not run reliably in conjunction with Multifinder.)

This is exactly the same as with all the other devices I have in my home, my TV, my video-recorder, my stereo, and my CD-player, my washer and dryer, my stove, my car. I do not want to have to study a manual before I can start to use them.

I list all of the above items deliberately, to emphasize that good educational software (indeed, good software in general) should allow the user to use his computer like any other household item. *Transparently*.

It seems to me that one of the problems we face at the moment with regards to mathematics software is that, not surprisingly, it is being developed by people who like using computers, who love designing and writing computer programs, and who have had many years of experience both as mathematicians and computer users. What with all that excitement, the poor end-user can so easily be forgotten. And then we are left bewildered when some of those end-users do not embrace our products with the enthusiasm our creations evoke in ourselves.

Though I cannot claim to be a 100% convert to Heideggerian philosophy, I lived in the Bay Area long enough for some of it to rub off, and I cannot see any better way to end this article than by advising anyone who has not already done so to read the book *Understanding Computers and Cognition: A New Foundation for Design*, by Terry Winograd and Fernando Flores (Addison-Wesley, 1986). The classroom computer should be like the Heideggerian hammer described in this book. You should be able to use it without being consciously aware of its presence.

The computer, and in particular the Macintosh and machines like it, has presented us with a tremendous opportunity to elevate our mathematics teaching to a new level. But it has to be done properly, or it is best not done at all. Let's make sure we get it right.

Almost No Stuff In, Wrong Stuff Out

J. Douglas Child*

I'm somewhat disturbed by the article written by Keith Devlin titled "The Right Stuff". But then I've been using a CAS in the teaching of calculus for four years. The issues are quite subtle and run more deeply than Devlin ever takes time to imagine. The assumption that only "appliance" software (i.e., simple and sharply-focused software) is valuable for teaching beginning students runs counter to all of the experiences I've had. I believe appliance software is desirable, but certainly not necessary. Given the conclusions of the article, how can it be true that our non-major calculus students easily use a CAS to help them with the computational aspects of calculus? I've spent many hundreds of hours observing and interacting with students as they use computer algebra systems to solve problems and look

for examples. I find Devlin's conclusion about the use of CAS without foundation and, even worse, that his methodology for investigating powerful, new software packages as teaching tools is seriously flawed.

In spite of the fact CAS' are far from perfect programs, they are having a dramatic impact on calculus courses. Curricula are changing, new teaching methods are developing, and new methods for solving problems (which include step verification) are evolving. One wonders then, what was the context for Devlin's investigations? His conclusion is that for all entry level students, all kinds of courses, all teaching methods, and all instructors, CAS should not be used. What an incredible conclusion. So quickly obtained. In fact, there are many interesting, 'successful' projects underway. Some of these will be covered in two MAA Notes Volumes currently being prepared.

And now to *Calculus T/L*. The most bothersome thing about Devlin's comments is that they are based upon totally false ideas about what *Calculus T/L* is or how it should be used. I am an expert in such matters because I am its author.

Calculus T/L began as a project to turn a command-line driven computer algebra system, *Maple*, into one that utilizes the graphic interface of the Macintosh. It implements a number of innovations including easily reusable results, concrete mathematical objects that students can "get their hands on", facilities for developing pattern matching skills, and an object-oriented drawing program environment for assembling solutions. A goal was to enhance the level of communication of symbolic information so that some basic cognitive problems of students might be investigated. Again, the issues run deep. Many fundamental questions remain open. User interface design is an art that depends heavily upon trial and error. One of the reasons for having *Calculus T/L* published is to make its new ideas (both good and bad) available for serious examination by others. What's good will be used in future efforts by others; what's bad will be lost forever. I never dreamed that *T/L* would be ripped apart in print before it was even published. It's time to consider the basis for Devlin's comments.

The main topics of the *T/L* portion of the previous article are the trapezoidal rule and a particular alternating series. While considering these examples, Devlin believed he was using integral parts of *Calculus T/L*, but he was actually using parts of *T/L* documents which are provided as examples of the kinds of activities *T/L* can be used to support. This fact is stated on a card that comes in the *T/L* product box. In fact, these example documents are advanced examples which assume a semester and a half of experience with *Calculus T/L*. There is nothing like jumping right into advanced "toing and froing". *T/L* documents are easily changed. If an instructor doesn't like a document he can easily change it

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or write his own. The problems mentioned in the article were ameliorated in the released version of *T/L* by the addition of a few comments. No changes to *T/L* were necessary. In most cases instructors will want to at least develop supporting paper documents and worksheets. Pencil and paper activities normally precede computer activities, especially for novice users. Note that *T/L* documents are similar to *Mathematica* Notebooks. The trapezoidal rule document simply contains most of the commands necessary to obtain information about its use for a particular definite integral. Students use this information as a basis for constructing complete solutions/discussions by adding textual comments, graphs, and tables. These are fundamental *T/L* operations encountered in the first or second week.

By the time students consider alternating series they will know about how to look for subsequences when considering the behavior of functions near points as well as when investigating the behavior of sequences. The sample documents that deal with limits of functions are much more detailed than the document used by Devlin because limits are normally considered near the beginning of calculus. One of these documents was recently used by non-major applied calculus students. No harm was done; no problems or complaints heard. Instead, the students are going back to their high schools and telling their teachers about *T/L*. Note that the instructor of the course uses weekly student journals as a vehicle for seeing how experimental activities are really received by students.

Various comments made throughout the discussion of *T/L* show that Devlin has a different view of *T/L* than its author. Statements like "The main instruction method is the familiar 'programmed learning' routine..." "But, this package is supposed to explain the trapezoidal rule..." and "loss of the mathematics be presented" seem to describe something other than *T/L*. Where did he get such ideas? For one thing he is proud of not having "the 'manual' at hand". *Calculus T/L* comes with a User Guide that begins by describing what *T/L* is and how it might be effectively used. Chapters titled Functions, Graphing, Limits, Derivatives... follow. *Calculus T/L* is simply a new kind of tool to be used by able instructors. It is not a program that claims to teach (and learn?). Most of the sample *T/L* documents supplement student learning activities; they are never intended to be presentations to passive students.

The main reason Devlin missed the mark is that he asserts that CAS and *T/L* are not appliances, and then proceeds to investigate *T/L* as if it were an appliance, and hence naturally concludes it is a disaster (as an appliance?). In some sense *T/L* may be better than an appliance; it can be used to create them.

I agree with Devlin's criticisms about poor cosmetics. Last summer we wrote code that improves the pret-

typrinting of mathematical expressions. Prettyprinting everything that *Maple* produces is a difficult job. The version currently running on my desk contains none of these flaws. The testing cycle is quite long so these changes won't appear until an early update of *Calculus T/L*.

For students who only use *T/L* to compute derivatives, integrals, ... and draw graphs, it is well worth its modest price. For instructors who are looking for a powerful tool for implementing student learning activities, it may be a real bargain. I wish it were better; with your help it will be. Constructive criticism is welcome.

Reviews of Mathematical Software

FFTLIB by PC Scientific

Reviewed by Herb Holden
Gonzaga University

FFTLIB is a library of FORTRAN subroutines for performing a variety of discrete Fourier transforms on IBM PCs. The product is distributed on 5 1/4 or 3 1/2 diskettes and consists of object code libraries of FFT algorithms, a demonstration program, eleven interactive test programs, seventeen skeleton programs to facilitate program development, and a 340 page tutorial and reference manual. The FORTRAN compilers which are supported are:

- IBM Professional FORTRAN 1.30
- Lahey FORTRAN 2.22
- Microsoft FORTRAN 3.31 or 4.01
- Ryan-McFarland FORTRAN 2.42

A hard disk is strongly recommended. A numeric coprocessor is desirable as well as a graphics card (Hercules, CGA, EGA, MCGA, or VGA).

The various transforms which may be accommodated are:

One Dimensional

Real data sequences of arbitrary length;
Sine transform of odd real sequences of arbitrary length;
Cosine transform of even real sequences of arbitrary length;

Complex data sequences of arbitrary length.

Special subroutines are provided for sequences of length a power of two, half-wave symmetry, and quarter-wave symmetry.

Multi-dimensional

Real or complex data of length a power of two in each dimension;

Real or complex data of arbitrary length;

Real or complex data stored on disk and length a power of two in each dimension.

This library evolved from the software package *FFT-PAK* developed by Paul Swarztrauber at the National Center for Atmospheric Research. The primary algorithm used is Stockam's algorithm [1] whose speed increases when the length of the data sequence has many factors. Some best case and worst case results for the forward transform of a real data sequence of length n are:

Powers of two		Primes	
n	secs	n	secs
64	.16	61	2.47
128	.44	127	10.77
256	.99	251	42.24
512	2.31	509	174.06

These times were obtained on an IBM PS/2 Model 30 (10MHz) without a coprocessor. The test program was compiled with Microsoft FORTRAN 4.1 using the compile time options /AL /FPC. (This is the only FORTRAN compiler I have used on a PC. It seems to be an excellent compiler, however, the environment is reminiscent of a punched card system.)

The library subroutines only process real data of type REAL which provides six decimal digits of accuracy. Since higher precision real types cannot be used, the value of a coprocessor is increased speed only. Any increase in accuracy is marginal.

The documentation is good and ample examples are provided. The index and the bibliography are rather brief. Source code is not provided.

This software is marketed as a joint venture between PC Scientific and McGraw Hill Book Company. PC Scientific was most helpful in providing information about their product. I called six different offices of the McGraw Hill Book Company and could not find anyone who had heard of this software. (Just what every software developer dreams of.) Each McGraw Hill representative was sympathetic, provided me with the phone number of another McGraw Hill office to try, and wished me good luck. (Once I was given the number of HBO in New York.) My impression of McGraw Hill is that their staff is very courteous.

PC Scientific also markets other subroutine libraries. They are:

MINPACK1-LIB for nonlinear systems;
FITLIB for curve fitting (reviewed in *Notices* 3/89);
SPARSGEM for sparse systems of linear equations;
QUADLIB for numerical integration;
ODELIB for systems of first order ordinary differential equations.

Each package sells for \$350. Further information can be obtained from:

PC Scientific, Inc.
4710 Debra Lane
St. Paul, MN 55126

Their phone number is 612-830-1232. Other phone numbers of interest are McGraw Hill at 212-512-2000 and HBO at 212-512-1000.

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Call #: TK5102.5 0245
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Call #: TK5102.5 M216 1979

Three Programs for the NeXT: Groups, Rubik Algebra, and Orbit

Reviewed by Suzanne M. Molnar*

Among the first mathematics applications written for the NeXT computer are *Groups*, *Rubik Algebra*, and *Orbit*, written by Charles G. Fleming and Judy D. Halchin of Eastern Illinois University. Since these are the first reviews of NeXT software to appear in this column, a few words about the machine, which was developed with the higher education market in mind, are in order.

The standard NeXT computer comes with 8 megabytes of memory, a 256 megabyte erasable optical drive, and now includes a 40 megabyte "accelerator drive" which serves to speed up response time from that of the original machine. A microphone jack and speaker are built in which provide CD-quality sound. Also included is a 17-inch monochrome, flat screen monitor having a $1120 \times 832 \times 2$ resolution, a keyboard, and a two-button mouse. The computer itself is a one-foot cube which is attached to the adjustable display by a three-meter cord allowing the user to place the unit on the floor leaving only the small "footprint" display device on the work area. For this review I used a machine with 12 megabytes memory and an optional 330 megabyte hard disk.

System software includes Mach/UNIX®, which allows for networking and multitasking. The latter is reflected in multiple open windows and the ability to have several programs running at one time. Also included which is of interest to program developers are Interface Builder™, a programming tool part of the

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NextStep[®] object-oriented environment, and the programming languages Objective[®]-C (in which these programs were written) and Allegro CL[®] Common Lisp. Among the bundled applications are *Mathematica*[™], GNU TeX, WriteNow[™], a word-processor, electronic mail with voice, and Digital Library, including Webster's Ninth New Collegiate Dictionary[®] and, for those who may need it, The Oxford University Press[®] Edition of *William Shakespeare: The Complete Works*! At a higher education price of \$6,495 for the standard configuration of hardware and software outlined above, the NeXT computer is competitive with similarly configured UNIX systems and the Macintosh IICX. To serve the needs of the network user the computer is also available without the optical disk drive for a cost saving [1].

Groups. This program can help students learn about all of the finite groups of orders up to 20. After making a selection, a group table is displayed. Figure 1 (See next page) illustrates the various options available for the dihedral group D4 (the notation used in the program). Upon selecting 'Inverses' and 'Orders', respectively, tables are displayed of the group elements, their inverses and orders. In a similar fashion the 'Conjugacy Classes' option displays a list of the conjugacy classes of the group.

The 'Subgroups' option has several sub-options. The user may choose to list all of the subgroups or all of the normal subgroups of the group under consideration. When more subgroups exist than fit in the window, a slider can be used to move through them (See Figure 1). The 'Cosets' and 'Quotient Group' options display lists of all subgroups and normal subgroups, respectively. After clicking on a subgroup, the list of cosets is displayed or the quotient group table is displayed. The 'Center' and 'Commutator Subgroup' options list elements of the group, shading in the center and commutator subgroup elements both in that table and in the group table. The one feature of the program which allows the user to more actively interact with the group is the 'Test a Subest' option. Here the user may select a subset of the group in order to determine if it is a subgroup. The selected elements are shaded in the group and cells flash where closure fails.

The NeXT interface with its multiple open windows displaying the information about a group and the use of Greek symbols were welcome to this reviewer. In comparison to *Exploring Small Groups* [2], which allows for a more open-ended, flexible, discovery approach, this program is much more static. However, with appropriately designed exercises, students may find *Groups* a useful aid to help them clarify the concepts incorporated into the program.

Rubik Algebra. This program has the same name and is by the same authors as the one previously reviewed in

this column [3]. It has the same features as that program with the additional ease of use of the NeXT program seen in Figure 2 (See next page) the Control Panel allows the user to manipulate the cube either using buttons or by entering one's own sequence of face rotations. 'Turn the cube' turns the entire cube 90 degrees in the direction indicated with respect to the front face. Repeatedly selecting 'Undo' takes one backwards through a sequence of moves. 'Redo' redoes an undo. In order to repeat a sequence of moves one specifies the number of times to perform the sequence.

The face rotations may be selected by using the buttons 'Front', '-Front', etc., where the unsigned word indicates clockwise and the signed word is counterclockwise. The same convention is used for entering one's own sequence of moves, with the letters f, b, l, r, u, d corresponding to David Singmaster's [4] Front, Back, Left, Right, Up, Down faces, respectively. Figure 2 shows the cube after the sequence -r 2u -f has been repeated 3 times. This sequence twists three corners clockwise, as seen in the Cycle Decomposition window, which lists corner cycles and edge cycles.

The program has its own library of sequences of moves; it is an easy task to add your own favorite move sequences to the library. Help is available for using the 'Control Panel', 'Cycle Decomposition', and 'Library of Sequences' options. Figure 2 shows the Help window for the Control Panel displayed. For someone using the program to 'play with the cube' this is a nice reminder to have readily available. What is also extremely useful is that you can press 'Unscramble' if you get the cube hopelessly out of order - unlike the real thing which has no easy way out for those who are not expert cubists!

As with the IBM-compatible version [3] it is best suited for "individual investigation" for motivating and exploring concepts in group theory. Together with David Singmaster's book [4, 5] one can learn a lot of group theory from *Rubik's Algebra*. The NeXT version shows the cube in white and five shades of grey, some of which can be difficult to distinguish. I performed the operation on a real cube to convince myself that the cube illustrated in this review has all six colors shown after the sequence of moves. This is the only drawback to the program which is due to the fact that NeXT does not currently provide for color, which is to be available this year.

Orbits. This program allows the user to experiment with the nonlinear dynamical system obtained by iterating the function $f(x) = Ax(1-x)$, by investigating the orbit $-x, f(x), f(f(x)), \dots$ of a point in the interval $[0, 1]$. The system is often described by the finite difference equation $x_{n+1} = Ax_n(1-x_n)$. Once an initial value is selected the behavior of the system is determined. The program initially presents the window as seen in Figure 3 (See page 431), obtained from

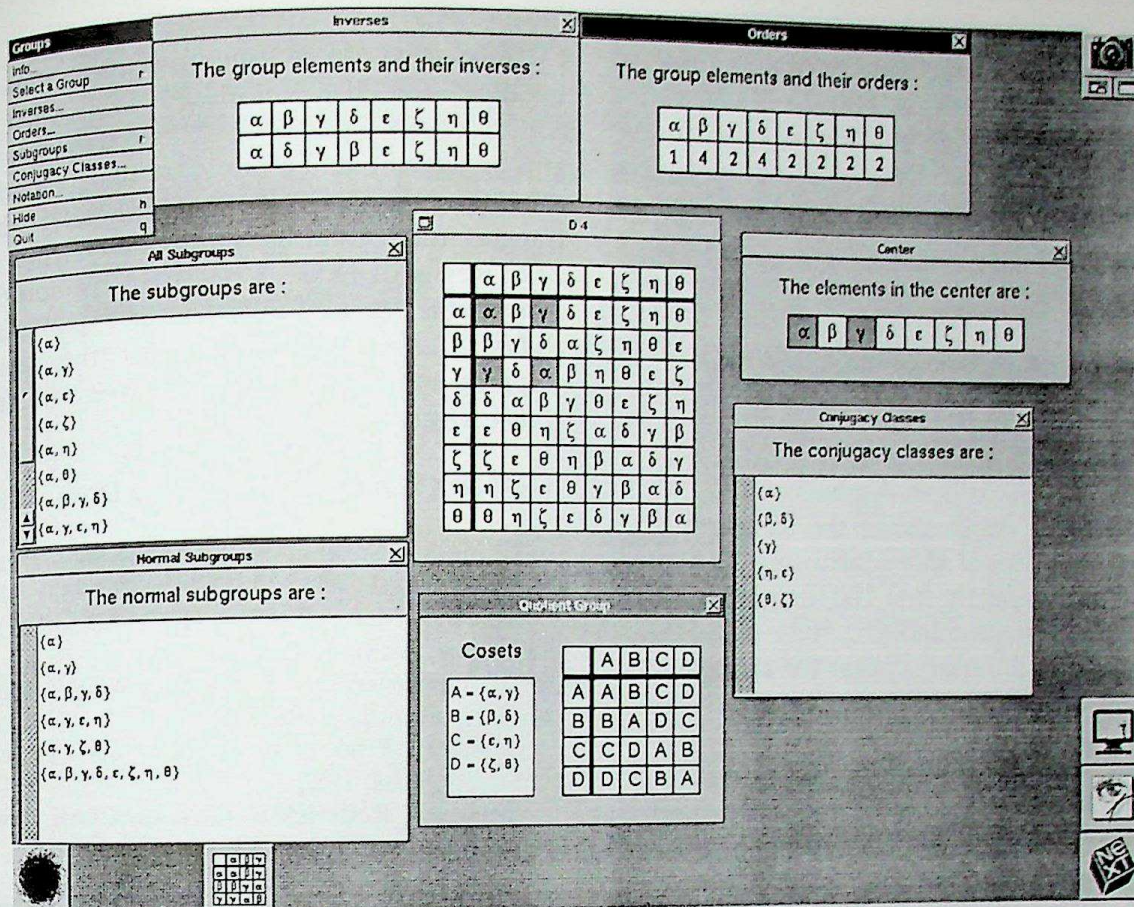


Figure 1

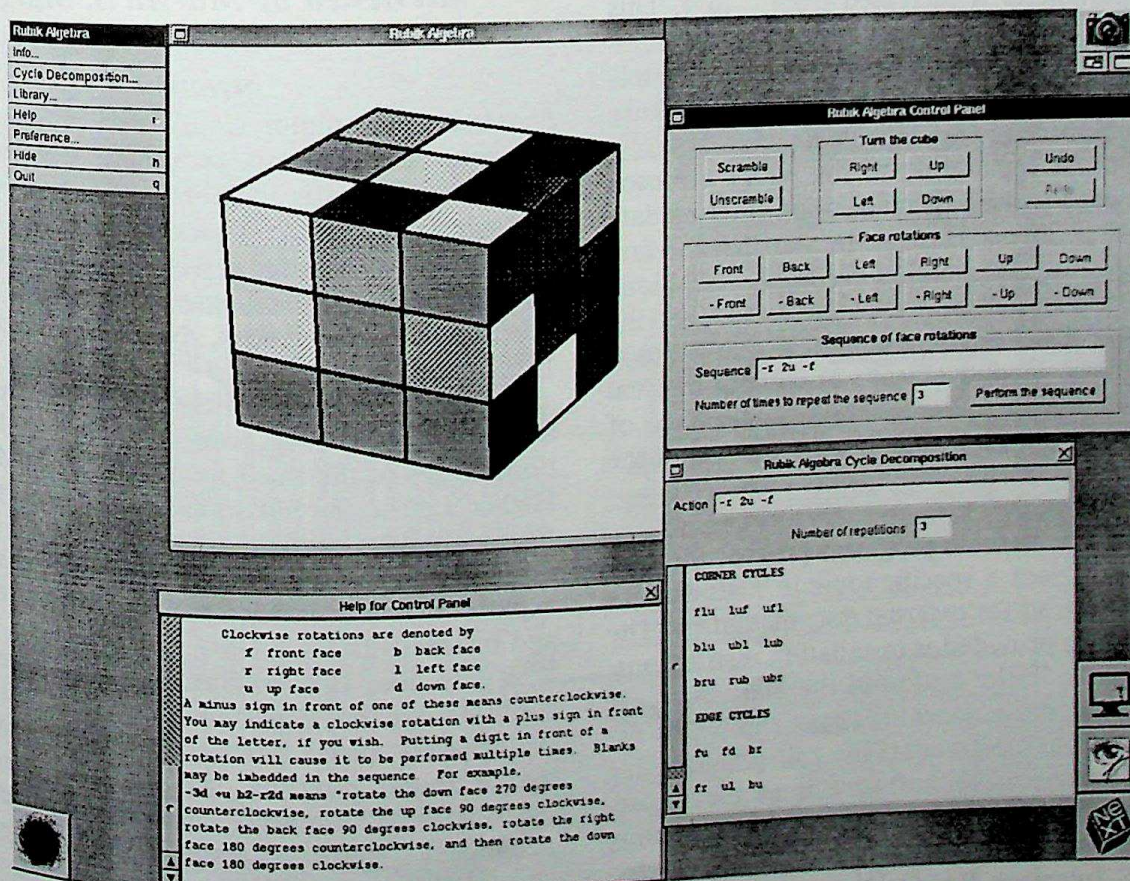


Figure 2

'Graph the Asymptotic Orbit' option which displays 1000 terms of the orbit beginning with the 1001st term. One may change parameter A , the initial value for x , and the number of iterations either by using the sliders or entering specific values. Using the latter method to make successive changes to parameter A , then selecting the 'Graph the Entire Orbit' button and getting the same graphs, I finally realized that although the numbers change visually, the new values are not active. One must press Return to register the change, which is indicated by movement of the slider. At long last I do not press Return at the end of each line of text – old habits of using the Return key had to be re-learned.

Figure 4 (See next page) shows the same orbit as Figure 3 with the same initial value only using the 'Graph the Entire Orbit' button for the first 100 iterations. Figure 4 also shows other options available from the main menu, namely the 'Parameter Bounds' option for changing the bounds on A , and the 'Composition' option which shows a graph of the function $f(x)$ composed with itself a specified number of times. None of the graphs has the axes labeled, which would be useful.

As the figures in this review indicate, the program gives experimental evidence of the chaotic nature of the system for $A = 4$. It was easy to generate other interesting graphs to illustrate convergence to zero, to a fixed point different from zero, and to several fixed points, as the parameter A increased from 0 to 4. This program provides an easy way to discover the transition from order to chaos of the logistic map, a simple mathematical model for such phenomena as turbulence in fluids and evolution of populations. [6]

The voice output capabilities of the NeXT are used to tell the user when an error is made upon entering data and to describe the error. This can be startling the first time it happens, but I personally prefer the technique to an obnoxious beep and no indication as to what the problem may be. One small irritation is that I could not resize the main window (Figure 3) without unusual things happening which included the disappearance of some sliders. When this happened it was best to quit the program and to start over.

Conclusion. Each of these programs provide the user with the ability to learn a specific topic in mathematics with little (if any) need for external documentation. The only documentation provided is installation instructions. Each program has a 'Help' option in the main menu. If one has used a Macintosh, learning to use the NeXT for these programs is easy. However, the full potential for the NeXT and mathematics software is in the future. The authors have plans to develop other software using *Mathematica*TM with a user friendly interface. Together with the NeXT Interface BuilderTM other mathematics software is sure to follow.

Developers are coming up with various strategies for handling the distribution of application software. At a cost of \$50 per optical disc this can be expensive and inconvenient. To purchase these programs one must send the authors an optical disk onto which they will transfer the programs. Address: Halchin and Fleming, 2122 Reynolds Drive, Charleston, Illinois 61920. *Group Rubik Algebra* is available for the same price plus shipping and handling. *Orbit* is free with the purchase of *Rubik Algebra*.

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Phaser

Reviewed by Marvin S. Margolis*

Introduction

Phaser is an animator/simulator for dynamical systems that runs on IBM and compatible personal computers. The software is included in a combination manual and illustrated guide to experimental dynamics. The manual's formal citation is *Differential and Difference Equations through Computer Experiments*, Second Edition, by Hüseyin Koçak, New York: Springer-Verlag, 1989, pp. 224.

According to an article in *Academic Computing*, a magazine covering computer use in higher education, judges at the third annual EDUCOM/NCRPTA Higher Education Software Awards competition named *Phaser* the best mathematics software of 1989. The article's mathematics reviewer praised *Phaser* as "... an explorational [educational] tool that is inviting, engaging and instructive."

I also like the program because it motivates the study of dynamical systems. When I first tried *Phaser* it displayed "phase portraits" for differential equations that I found puzzling. As a result I began reading the referenced literature on differential equations and dynamical systems. As I studied the references, I began

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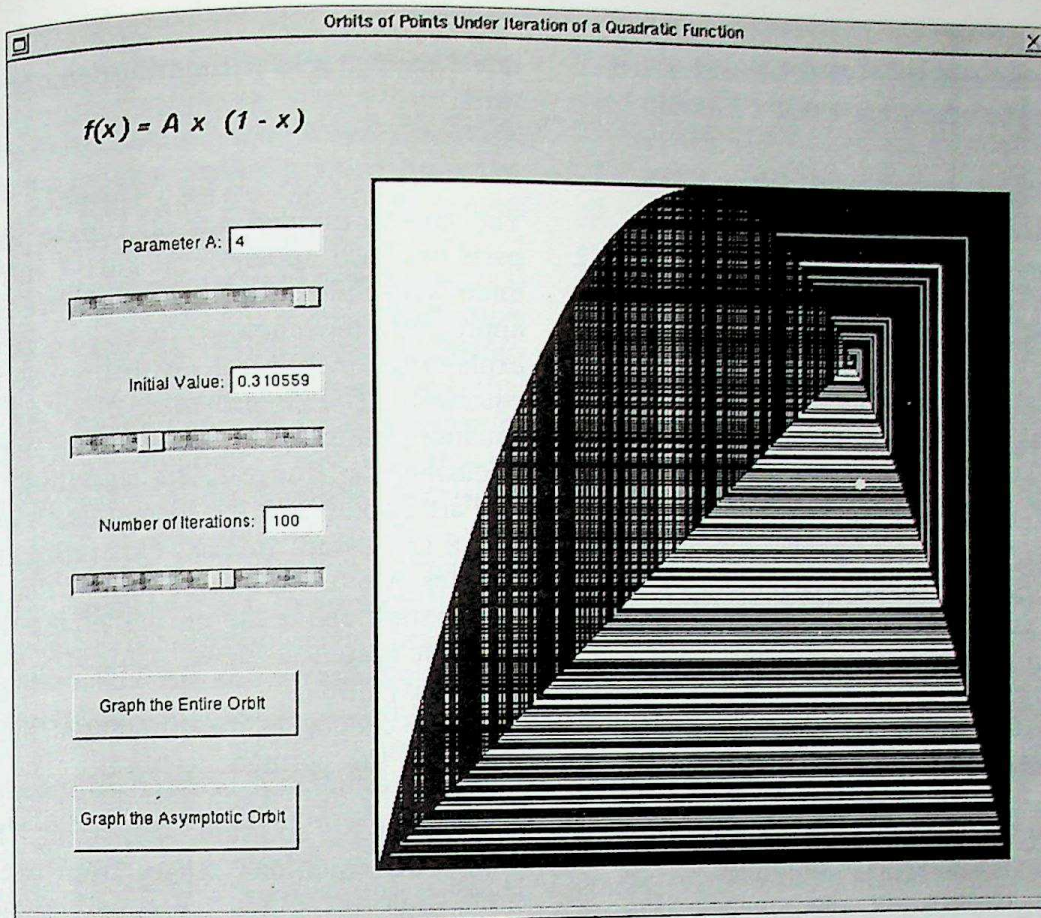


Figure 3

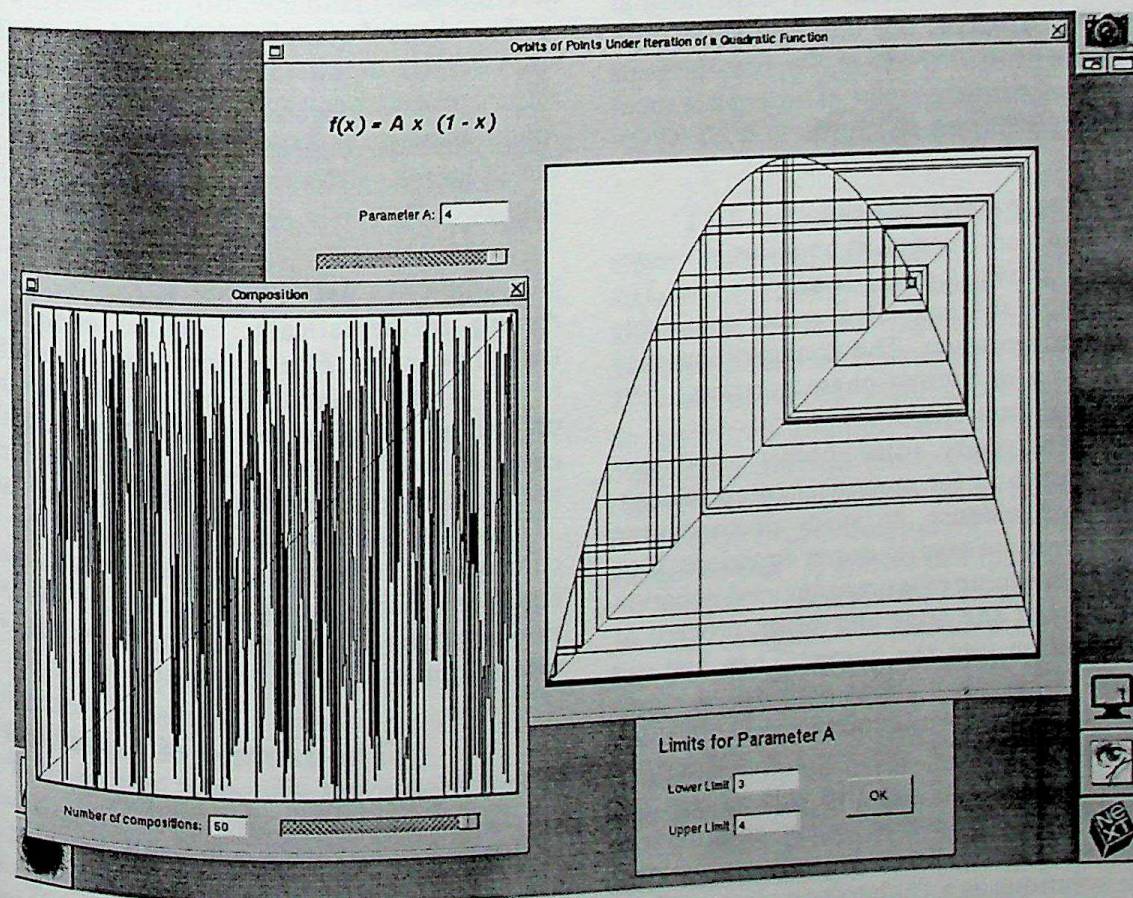


Figure 4

to understand dynamical systems better than I ever had in the past. Without the program I doubt I would have been so motivated.

Hardware Requirements

To run *Phaser*, one needs an IBM PC, XT, AT, PS/2 or compatible, a DOS Version 2.0 or higher operating system, 256K-bytes of memory and an IBM CGA, EGA, or VGA monitor. A color display is best although a monochrome monitor will work. With monochrome some colors (such as red) may be invisible.

How Can One Use *Phaser*?

Lecturers can use *Phaser* to supplement beginning and advanced courses in differential/difference equations. *Phaser* presents specific examples of differential/difference equations ranging from the most rudimentary, appropriate for the beginning student, to the highly complex, suitable for the research mathematician. Used alone it can not substitute for the inherently difficult study of the theory of dynamical systems. Rather, it is a complementary tool for doing mathematical experiments and illustrating theory with specific examples.

The author of the program and manual, Hüseyin Koçak, is a professor of mathematics at Brown and Miami Universities. In conceiving *Phaser* his motivation was to create a "... work station for experimental dynamics, one where students not only can get a taste of the current excitement in the field, but also perhaps discover new dynamical phenomena in an environment free from extensive programming efforts."

How *Phaser* Works

Because *Phaser* only uses menus, it requires no computer programming knowledge and is easy to use. The user first creates, with the help of a menu, a suitable window (screen) configuration. The configuration may display a combination of views—phase portraits, texts of equations, Poincaré sections, etc.

Next, the user can specify, from another menu, various choices in preparation for numerical computations. One can choose, for instance, to study preconfigured equations from a library of several dozen equations. One quickly appreciates the value of a preconfigured equation once one goes through the trial and error process of entering a new equation into the library. Then one can compute solutions of these equations with different initial conditions or step sizes, while interactively changing parameters in the equations.

From another menu, the user can manipulate the solutions graphically, for example, either rotating the images or taking sections of them. During simulations, one can save the solutions as a (1) hardcopy image of the screen, (2) printed list, or (3) form that one can reload

into *Phaser* at a later time for demonstrations or further work.

The Manual

The author divided the 224 page manual into three parts and two appendices. Part 1 introduces the ideas underlying differential and difference equations and the appropriate terminology. In an overview the author explains the numerical algorithms he uses to solve the equations. *Phaser* provides three algorithms to solve equations numerically, an Euler, an Improved Euler, and a fourth-order Runge-Kutta algorithm.

Part 2 comprises the formal user's manual and begins with a 15 "lesson" tutorial illustrating almost all *Phaser* features. A reference guide follows that contains detailed information about the entries of the three main menus and nine graphical views. Appendix A provides a quick reference guide.

Part 3 catalogues the differential/difference equations stored in the permanent library. The author sorts the equations by dimension and difference/differential type determined by solution algorithm. The order of the differential equations ranges from one to four dimensions while the difference equations span one to three dimensions. Appendix B lists all difference/differential equation names stored in the library and their brief descriptions.

The manual contains 108 illustrations. These reduced sized screen dumps show the results either of various *Phaser* operations or particular equation solutions. I found the figures especially helpful when first learning the program. The references at the end of the manual help also.

Difference Equations

Among mathematically oriented commercial software that I have tried, *Phaser* uniquely solves difference equations. As with differential equations, *Phaser* concentrates on the geometric ideas associated with the difference equation theory. For example, it uses stair step diagrams to analyze one-dimensional difference equations.

The solutions for difference equations involve more complexity than the comparable ones for differential equations. For one dimension, the library provides equation examples with not only "fixed points" and "periodic orbits," but also "strange attractors."

The Library of Equations

A main feature of *Phaser* is its library of over 61 preconfigured equations. For each dimension, the author orders the equations roughly by increasing level of difficulty. One quarter of the library provides examples of an undergraduate course in differential equations. The other quarter the author designed for a graduate course.

The rest of the library reflects his own mathematical inclinations.

If the library does not contain one's favorite classroom example or research problem, the program permits one to formulate and add a new equation. *Phaser* has enough space for about forty user-defined equations.

The author chose the differential and difference equations for the library in order to study their qualitative properties. In the first stage in that process, one determines an equation's phase portrait by varying the initial conditions. One would like to know the limiting behavior of all the solutions of an equation. These sets grow in complexity as the dimension of the equation increases.

In the second stage of the qualitative study, one explores the possible changes in an equation's phase portrait as one varies the equation itself. In applications, for example, many models contain changeable parameters. By changing the parameters one can investigate the "robustness" of the system under small perturbations. "Bifurcation" theory involves studies of qualitative changes in the phase portraits of dynamical systems as one varies parameters. The author designed many examples in the library to illustrate "typical" bifurcations.

To give the flavor of the library equations, a list of some early equations in each library category follows:

One-Dimensional Differential Equations

1. Cubic1d - General one-dimensional cubic differential equation

Two-Dimensional Differential Equations

1. linear2d - General two-dimensional linear system
2. pendulum - Nonlinear pendulum on the plane
3. vanderpol - Oscillator of van der Pol: A unique limit cycle
4. predprey - Predator-prey equations, competing species, etc.

Three-Dimensional Differential Equations

1. lorenz - The most famous strange attractor
2. linear3d - General three-dimensional linear system
3. vibration - Periodically forced linear vibrations

Four-Dimensional Differential Equations

1. harmoscil - A pair of linear harmonic oscillators
2. kepler - Kepler and anisotropic Kepler problems

Library of Difference Equations:

One-Dimensional Difference Equations

1. logistic - The logistic map - the one that started it all
2. dislin1d - General one-dimensional discrete linear equation
3. discubic - General one-dimensional cubic difference equation

Two-Dimensional Difference Equations

1. dislin2d - General two-dimensional discrete linear system
2. gauss - Fast computation of elliptic integrals
3. quad1 - A quadratic map on the plane

Third-Degree Difference Equations

1. dislin3d - General three-dimensional discrete linear system
2. act - A three-dimensional cubic map

Chaos

As one would expect given the role that computers play in the new science, *Phaser* helps illustrate many ideas in chaos theory. James Gleick's best-selling book about chaos provides historical details about several equation systems in *Phaser's* library.* Conversely, *Phaser* provides concrete examples of some dynamic models discussed in Gleick's book. In particular, *Chaos* and *Phaser* feature the Lorenz, pendulum, and logistic equations. Both also illustrate the idea of strange attractors.

When I first tried *Phaser*, I was unclear why a "phase portrait" constituted an important differential equation graph. *Phaser's* brief manual offered little help. Gleick (page 134) explained it most elegantly:

"The strange attractor lives in phase space, one of the most powerful inventions of modern science. Phase space gives a way of turning numbers into pictures, abstracting every bit of essential information from a system of moving parts, mechanical or fluid, and making a flexible road map to all its possibilities."

Other Differential Equation Software

Other mathematically oriented commercial software is capable of solving differential equations. As far as I know none are as thorough as *Phaser* nor do any attempt to solve difference equations. For example, *Math CAD* sells an advanced mathematics applications pack as an extra cost addition to the regular program. Among other mathematical tools, the math pack features three differential equations models, solution of a (1) first-order differential equation, (2) second-order differential equation, and (3) system of differential equations.

Matlab's functions for solving differential equations include: (1) ode23 - second/third order equations using the Runge-Kutta solution method (2) ode45 - fourth/fifth order equations using the Runge-Kutta-Fehlberg method.

Gauss sells an extra cost addition called *SimGauss* that allows one to simulate dynamic models. Since it is not menu driven it is probably harder to use than

*James Gleick, *Chaos: Making a New Science*, New York: Viking Penguin, Inc., 1987.

Phaser. I do not know whether *SimGauss* possesses more dynamic analyses capability than *Phaser*.

I am unaware of other mathematically oriented software that solves differential and difference equations. *Phaser's* easy to learn menus, ready to run equation library, and convenient graphing provide advantages over the above-mentioned competition.

Conclusions

I concur that *Phaser* is "... an effective tool for performing mathematical experiments and for illustrating the theory of dynamical systems with concrete examples..." as the review of the second edition in *Academic Computing* stated. It can help students and probably researchers also to access a sophisticated and elegant part of mathematics.

The Collected Papers of R. H. BING

Sukhjit Singh, Steve Armentrout, Robert J. Daverman, Editors

A powerful mathematician and a great problem solver, R. H. Bing laid the foundation for a number of areas of topology. Many of his papers have continued to serve as a source of major theoretical developments and concrete applications in recent years. One outstanding example was Michael H. Freedman's use of Bing's Shrinking Criterion to solve the four-dimensional Poincaré Conjecture.

This two-volume set brings together over one hundred of Bing's research, expository, and miscellaneous papers. These works range over a great variety of topics in topology, including the topology of manifolds, decomposition spaces, continua, metrization, general topology, and geometric topology. In addition, there are a number of papers in the areas of convex functions, linearity, and conformal varieties. The introductory section in the first volume provides

historical background on Bing's life and achievements.

This collection will appeal to mathematicians in all areas, and especially those in topology, as well as students, historians, and educators in the mathematical sciences, for it provides a complete historical summary of the mathematical events in the life of the man and the mathematician, R. H. Bing.

Contents:

I. R. H. Bing: An introduction; An editorial preface; R. H. Bing: A study of his life, by S. Singh; A chronology of R. H. Bing; Ph.D. students of R. H. Bing; R. H. Bing: October 20, 1914–April 28, 1986, by R. D. Anderson and C. E. Burgess; Abstracts by R. H. Bing; II. Papers of R. H. Bing; III. Classifications of works of R. H. Bing; Publications of R. H. Bing: Classified by the year; Publications of R. H. Bing: Classified by subject matter; Works not included in these volumes; Permissions.

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Inside the AMS

The Participant's Guide to Planning the January Meetings

Many years ago, the Society recognized the need for professional attention to its program of meetings and conferences, and over the last twenty-five years it has developed an experienced staff of eight full-time and two part-time Meeting Planners. Meeting Planners are a relatively new breed of professional. It was only a year ago, for example, that the U.S. Department of Labor approved the title of Meetings and Convention Manager for inclusion in the National Directory of Occupational Titles and Codes. It has only been about five years since Metropolitan State College in Denver began offering a degree in meeting management, and that colleges and universities which offer degree programs in hotel/motel management began to include a number of meeting-planning courses in their curriculum. The Society's Meeting Planners are dedicated first and foremost to making meetings and conferences as fruitful and rewarding for the mathematicians attending them as possible, in as unobtrusive a fashion as possible. They are the people you see mostly behind the scenes at meetings, wearing blue badges and a frazzled look, applying crisis management techniques to the multitude of problems which arise each day in order to ensure that they do not interfere with the participants' enjoyment of the meetings.

One of the events this staff helps to bring to the membership each year is the Joint Mathematics Meetings in January, which includes the Annual Meeting of the Society. These meetings are joint with the Mathematical Association of America (MAA), and provide a showcase for sessions of several other organizations as well. Joint Meetings are governed by the AMS-MAA Joint Meetings Committee (JMC), composed of the Executive Directors of the Society and the Association, the AMS Secretary, and the MAA Associate Secretary for Meetings. The Society's Director of Meetings is the JMC's professional consultant.

The process of putting together the January Joint Mathematics Meetings begins several years in advance, when the JMC begins to select two or three cities which are likely to have the requisite facilities. The staff will have already done a preliminary investigation of

each site over the telephone and by mail in order to determine whether or not it deserves a closer look. The January meetings alternate between cities east of the Mississippi in even-numbered years, and cities in the western half of the country in odd-numbered years, but there are a number of factors which influence the JMC's deliberations, other than general geographic location. First and foremost, the site must offer facilities adequate to house most of the meetings under one roof, with the remaining facilities within a few minutes' walking distance. Our meetings require an inordinately large amount of meeting space when compared with similar size meetings of other associations. A quick comparison of the timetable from the New Orleans meetings in 1969 with the Phoenix meetings in 1989 reveals that the number of events on the program increased from 103 to 185, or by about 80 percent. To say that today's meeting participants are getting more value for their registration dollar is no exaggeration! (The number of staff working the meeting, however, increased by only 20 percent, so it's understandable that they sometimes seem to be a little overwhelmed by it all!)

After adequate facilities, the next requirement to be satisfied is that there are between 2,000 and 2,400 reasonably priced sleeping rooms within easy walking distance of the convention center. Given these two nontrivial requirements, the number of cities which can host the Joint Mathematics Meetings on either side of the Mississippi is understandably small.

The third major requirement is affordability, not only by the participant, but by the Society and the Association as well. There are other factors which are considered, of course, such as climate (hence a decided proclivity for locations in the south or far west), easy and affordable access by mathematicians from all parts of the country, and a minimum number of interesting things to see and do.

Once the staff and the JMC are convinced that a particular city has the potential to satisfy all three major criteria, a site inspection is done and a report and recommendation is submitted to the JMC at its next meeting. If the site and suggested dates are approved,

they are then submitted to the MAA Board of Governors and the Society's Secretary and Associate Secretaries for formal approval before being listed on the Calendar of Meetings on the inside front cover of the *Notices* and in *Focus*. This can take as long as one or two years once the city initially comes under consideration, but generally, these announcements take place four to five years prior to the meetings. Not much is said about the meetings after that, until the various deadlines begin to be announced, such as the deadlines for organizers of special sessions, for abstracts for contributed papers, and for abstracts for special sessions. In the meantime, staff is gathering information from a number of sources and organizations for inclusion in the first announcement of the meetings, which is input to a T_EX file to produce camera copy for the *Notices* and *Focus*. At the same time, work is being done to prepare a city map showing the location of the various hotels and convention center, to prepare the timetable for the meetings (currently produced in Pagemaker 3.02 software on a Macintosh IIfx), and to prepare the preregistration/housing, applicant, employer and minicourse forms. The first detailed announcement of the meetings, including these forms, is published in the October *Notices* and *Focus* in the year preceding the meetings. This is followed by a brief update in the November *Notices*, with the scientific program appearing in the December issue.

Sometime during the fall two years preceding the meetings, the Secretary of either the Society or the Association (they alternate) seeks out a local mathematician willing to chair the Local Arrangements Committee (LAC) for the meeting. Usually, it is someone recommended by the Chairman at one of the major universities in the host city as having the attributes of a good organizer and a reputation for getting the job done on time. Once the Chairman has agreed to serve, he or she is appointed by the Presidents of AMS and MAA, and invited to attend the meeting of the JMC that following January in order to observe a January meeting in progress, and to learn from its Chairman what is involved. The remainder of the committee is appointed early in the year preceding the meetings. The Chairman is provided with a manual, and works closely with the staff during the year following on several aspects of the meetings, primarily the gathering of local information of various sorts, the recruiting of student helpers to assist in various ways during the meetings, and the organizing of special local events such as tours. Most of the local information that members see in the meeting announcements in *Notices* and the program at the meeting has been prepared and written by the Chairman and other members of the LAC. During the meetings, the local information section of the registration desk is staffed by members of the LAC and other volunteers from the community.

About one year out, another visit is made to the

host city by staff, usually the Meeting Coordinator and the Housing and Registration Coordinator, along with the AMS Associate Secretary for the meetings. This is a crucial visit for the latter since he schedules the Society's sessions and assigns meeting rooms to them; hence, he must be cognizant of the characteristics and seating capacities of all rooms that will be used. It is at this time that the final rates are negotiated for space and sleeping rooms, and the two staff members involved are acknowledged to be one of the toughest (and yet fairest) teams most hotel and convention center sales representatives have met, always keeping the membership in mind and representing its interests to the fullest. Usually formulas for calculation of the hotels' final rates have been agreed upon during the initial site visit, or during later negotiations. If, however, the formula results in an unfavorable rate at a particular hotel, then that property is given a chance to become more competitive before it is replaced by another hotel extending better rates. Also at this time, the convention center and headquarters hotel will have designated members of their staffs to serve as their in-house coordinators for the meetings, and detailed discussions are held with these individuals on what will be required of these facilities during the meetings. The Chairman of the LAC is invited to join in on the visit, and the role of this committee is more specifically outlined and tailored to fit the particular site.

In September of the year preceding the meeting, work by staff begins in earnest. A checklist of over a thousand items taking about 3,600 hours to complete has been developed in connection with the January meetings, and responsibility for specific parts are assigned to various staff members. What follows are synopses of some parts of this effort which may provide some insight into just what it takes to produce this meeting.

The Meeting Coordinator makes arrangements for most general aspects of the meetings, such as the official travel agent, telephones, U.S. mail, office equipment rental, on-site banking, staff travel, freight shipments, layout and design of the registration area, emergency procedures, catering, information packets for speakers, obtaining and printing of assorted lecture notes, various signs, on-site labor and clerical help, security, insurance and taxes. She also assists the Associate Secretaries of the AMS and MAA with room assignments for sessions and compiles information from all other coordinators for inclusion in the Book of Orders for the meeting. The Book of Orders contains the details of final arrangements for the many aspects of the meeting, and is sent to the concerned about two weeks prior to the first day of the meetings. When the Meeting Coordinator arrives at the site, she reconfirms all arrangements included in the Book of Orders, and acts as general trouble-shooter and problem-solver while the meetings are in progress.

The Audio-Visual (A-V) Coordinator is responsible for preparing a Request for Proposal for all a-v and computer equipment (plus labor), sending it out to a number of previously identified companies in the city where the meetings will take place, evaluating the bids, and making a recommendation as to the choice of vendor. Since the total equipment rental/labor bill for this item can run as high as \$25,000, this must be rigorously and carefully done. Once the vendor has been selected, the A-V Coordinator contacts all speakers on the program to determine precisely what equipment they will require in connection with their talks, and begins to draw up a list of firm requirements for transmission to the vendor(s). He is also responsible for preparing detailed descriptions of the setups and layouts for the various rooms used for sessions during the meetings, including a-v requirements. When he arrives at the site of the meetings, he meets with the various vendors and reconfirms all arrangements. During the meetings, he monitors all sessions, assists speakers and organizers with the operation of public address systems and the various pieces of equipment, and works closely with them on producing a successful presentation.

The Housing and Registration Coordinator and the staff of the Mathematics Meetings Housing Bureau prepare for processing of preregistration and housing for the meetings. This entails initializing the computer system which handles all record keeping and reports, including setting up computer codes for all items listed on the preregistration/housing form so that they can be efficiently input to the system. Included in this initialization are setting up lists of all available room types and rates in all hotels; clarifying procedures with the data entry clerks, emphasizing special features for the meeting and their handling; preparing for and supervising the mailing of various items, such as registration/housing acknowledgements, badges and programs; setting up electronic preregistration forms, acknowledgement letters for financial preregistration, and any other necessary forms and letters; making arrangements with the vendor for production of badges, including preparation of camera copy and printing of the various types of badges; ensuring that the various fiscal accounts to be used for the meeting are set up and ready to go. As the preregistration process begins, copy for on-site registration cards, badges, and any tickets required is developed and printed for shipping to the meeting. As preregistration/housing forms are received, payments are recorded and forwarded to the bank, housing assignments are made, the forms are coded and input to the system, acknowledgements are mailed, financial reports are sent to the AMS Fiscal Department, and rooming lists are sent to the various hotels, along with deposit monies. Badge reports are sent to the vendor, and as completed badges are returned, they are alphabetized, proofread against the original form, and prepared

for mailing. In the meantime, any hotel or registration changes received are input and new reports generated. Winners of the room lottery are drawn and notified. Just before the meeting, final reports are run, such as the alphabetical list of preregistrants which is posted at the meeting, and badges and programs are mailed. When the Housing and Registration Coordinator arrives at the meeting site, she visits all hotels being utilized and reconfirms all arrangements and reservations. During the meeting she assists participants with any problems they may encounter with housing or preregistration.

Over 100 committees meet during the January meetings. The staff is responsible for determining when committees will meet, assigning suitable rooms, checking for scheduling conflicts, and producing both personalized and master schedules for all concerned. Many of these committees must meet over breakfast, lunch, or dinner, and so catering arrangements must also be made, and accurate counts of those attending must be gathered in time to provide the facilities with the necessary guarantees.

As abstracts are submitted for presentation at the meetings, they are acknowledged and input into a computer system which sorts this information in several ways and produces reports which will assist the AMS Associate Secretary in preparing the Society's scientific program for the meetings. (Abstracts for papers on the MAA program are handled somewhat differently, and the MAA Associate Secretary is responsible for its scientific program.) About a week after the abstract deadline, the abstracts and reports are mailed to the Associate Secretary, who has about four or five working days to do all the scheduling and room assignments, and return the program to Providence where this additional information is input in order to produce camera copy for the *Notices* and the program mailed or handed out at the meetings. Once the final program is known, the Book of Orders can be completed, packets can be prepared for session chairmen, and a number of other last minute details can be finished in a flurry of activity just before the staff leaves for the meetings.

At last, exhausted and disheveled, your loyal Meeting Planners arrive in the meeting city, armed with carton slitters, Excedrin and program errata, ready for yet another opening day. So, when you see someone wearing a blue badge and a great big smile fly by you in the corridor of the convention center, simultaneously yelling into a walkie talkie at a houseman to put 50 more chairs in that room right now, handing out lecture notes with one hand and putting a bandaid on a participant's knee with another, it's not Superman or Wonder Woman, but the next best thing - your professional AMS Meeting Planner!

H. Hope Daly
Director of Meetings

Washington Outlook

This month's column is written by Hans J. Oser, who is a consultant to the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics in Washington, D.C.

Five months ago the President, speaking with the governors of the 50 states in Charlottesville, Virginia, announced his plan to improve the Nation's educational system. In his State of the Union Message in January, the President declared that he wanted "American students to be first in the world in science and mathematics achievement by the year 2000". During the last week of February, the National Governors Association met in Washington and endorsed six goals for education reform, fully recognizing that this would be a long and expensive process. In his speech in the East Room of the White House, the President congratulated the assembled governors for ushering in "a new era of education reform", by endorsing his goals for improving the American schools.

The House Committee on Science, Space, and Technology saw its patience rewarded on 28 February, when the Secretary of Education, Lauro Cavazos presented his long-awaited education agenda for the nation. The governors' action provided the opportunity for the committee to find out from the Secretary how the administration expected to proceed with reaching the President's goals. The committee also invited Erich Bloch, the NSF director, to state his views on the issues.

Here are some of the highlights from Cavazos' statement:

- * Mathematics and science are key elements, and unless the Nation does far better in this area than it has been doing, the President's goals will not be achieved.
- * The Department of Education (DOED) is ready to do its part to meet this challenge, and already is working with the National Science Foundation and the White House Science Adviser on a plan of action to meet it.
- * Science and mathematics must be for all students.
- * Science and mathematics literacy is essential for everyone. A citizenry that understands and appreciates

science must be our goal.

- * There must be educational access for all our citizens.
- * We must improve the teaching of science and mathematics.
- * We must strengthen the support throughout the educational system for high quality science and mathematics instruction and learning.

Cavazos described his budget proposal for fiscal year 1991, stressing collaboration with the NSF, both now and in the future.

Before questioning him, the committee also heard from Erich Bloch. His main points were:

- * There is a serious problem at the precollege level.
- * Interest in science and engineering among students has been declining. Only 15 percent of entering college freshmen planned to major in the natural sciences or engineering, compared to 20 percent in 1966.
- * Bachelors degrees awarded in these disciplines in 1988 declined 3 percent from the previous year. In computer sciences alone, the decline was 13 percent.
- * At the graduate level, we are not producing the number of scientists and engineers needed to meet the challenges of a competitive world economy in the years ahead.
- * In critical disciplines, the number of doctorates would be much lower if it were not for foreign students, which comprise more than 50 percent of the doctorates in engineering and mathematics.

Most of these facts are of course well known by now but they provided the stage for Bloch's discussion of the NSF's responsibilities in science education and human resource development at all levels, from precollege through graduate. He touched upon collaborations with industry and states and his special concerns about increasing the participation of underrepresented groups. Responding to the committee's request to address the issue of cooperation within the executive branch, he spoke of possible cooperation between the DOED and the NSF through stronger liaison between the two agencies, also and more stable working and funding arrangements, joint programs with the states and programs targeted at urban education, expansion and improvement of

national assessments of student achievement in the sciences and mathematics, and increased dissemination of high quality projects sponsored by the NSF and expanded distribution by the DOEd.

Bloch then proceeded to describe the administration's role as a goal setter and provider of leadership. To demonstrate the increased awareness of the leadership responsibility, Bloch said that D. Allan Bromley, the President's Science Adviser, will shortly create a new Committee on Human Resources and Education within the framework of the Federal Coordinating Council on Science, Engineering and Technology (FCCSET).

It became obvious, when the questioning by the committee members began, that their strongest concern was over the perceived lack of coordination in education policy within the executive branch. The Republicans did most of the questioning of Cavazos, which went something like this:

* What is the difference in the missions between DOEd and NSF and what have you done to coordinate your programs?

* What important issues are falling through the cracks between the two agencies?

* Does it do any good if Cavazos and Bloch are talking to one another, if word does not filter down in the two agencies?

* What is your awareness of the education programs in the Department of Energy?

* Do you find it shocking that the Secretary of Education has to ask for admission to the newly formed FCCSET committee on education and human resources?

Both witnesses agreed on the fundamental differences between DOEd and NSF programs. NSF awards all grants competitively, and typically for 3 years or longer. DOEd allocates 80 percent of its more than \$4 billion budget by various formulas, either to states or to school districts, typically on a year-to-year basis. The remaining 20 percent, even when competitively awarded, go to the states which in turn often use non-competitive criteria for their allocations. There are more than 200 separate programs in the Department of Education.

DOEd does not have as much control over how the money is spent, or how well it is spent, in contrast to the NSF, where peer evaluation is part of the allocation process, and where renewals are based on previous performance. On the other hand, in DOEd, some of the (congressionally mandated) formula allocations produce just the opposite effect: the least successful school districts get the preference. Another fundamental difference between NSF and DOEd is in the approach: NSF is responsible for mathematics, science and engineering

education, DOEd's responsibility is education in general.

The fundamental question that dominates the national debate over education reform is the proper role of the federal government. Bloch said it best, when he told the committee that the role of the President is to set goals and to create an environment that permits change. But reform cannot come from the top, it must be the concern of everybody in the educational system.

Congressman Ritter (R-PA) came closest to illustrating the dilemma of how much federal intervention was proper, when he rejected "mandates" as an instrument for the Bush administration. He then proceeded to question Cavazos on how he planned to use the fiscal power of the education department to steer the states toward accepting alternative certification of teachers, extending the school day, the school week, and the school year. Should we use the federal funding mechanism to leverage these goals?, he asked. And Cavazos agreed that leverage was a good idea, to use federal dollars as a carrot.

Bloch, the practical engineer, came closer to the heart of the matter, when he said market forces would be extremely important in the educational system. Teacher salaries are critical in this respect. The universities, he told the committee, had to learn this the hard way a few years back when they could not find faculty in computer science until they began to introduce differential salary scales. Bloch admitted that he would not object to considering leveraging with federal funds the educational programs in the states and in local jurisdictions.

The remaining time was mostly spent on outreach to the education community. Why does DOEd have no teachers award? Has DOEd invited the winners of the National Teachers Award to meet with the Secretary to listen to what they have to say? Does the National Diffusion Network (a DOEd clearinghouse that distributes information on, among others, NSF's curriculum development projects) employ anyone with a science degree? Unfortunately, Secretary Cavazos was forced to leave after two hours, citing an important commitment. The Science, Space and Technology Committee considered itself lucky to have heard from him after a full year of trying.

Correction

In the February "Washington Outlook", we failed to mention that the Joint Policy Board for Mathematics was the successor to an earlier joint committee of the three organizations (AMS, MAA, and SIAM) called the Joint Projects Committee for Mathematics. That committee was formed in 1973 to administer projects of common interest to the three organizations.

News and Announcements

Valentine Bargmann 1908–1989

Valentine Bargmann, Professor of Mathematical Physics, Emeritus, died of heart failure 20 July 1989 in Princeton Hospital, at the age of 81, nine months after the death of his wife Sonja. Bargmann exemplified a great European tradition in mathematical physics carried on in Princeton by H. Weyl, J. von Neumann and E. Wigner.

Bargmann was born in Berlin, Germany, April 6, 1908. He studied at the University of Berlin from 1926 to 1933. He moved to Zürich on Hitler's rise to power and wrote his doctor's thesis under the guidance of Gregor Wentzel. On the completion of his degree, Bargmann emigrated to the United States. (That flat statement is correct but it does not evoke the temper of the times. Bargmann received a five year German passport in 1931, before the National Socialists came to power, and used it to go to Switzerland to study. After Hitler took office, administrative regulations were issued withdrawing the citizenship of persons of the wrong "race". For that reason, if the German government had succeeded in finding Bargmann, it would have invalidated his passport. Nevertheless, the passport was accepted by the United States government as a valid basis for an immigration visa. The passport expired two days after he reached the United States in 1937.)

After receiving helpful suggestions from American physicists, Bargmann applied for a job at the In-

stitute for Advanced Study in Princeton and was accepted as an assistant. He was drawn into the work that Albert Einstein was carrying out on unified field theories of gravitation and electromagnetism. For several years, he and Peter Bergmann were Einstein's scientific assistants and coworkers in this enterprise. This work continued until 1943, when he undertook war work on shock waves with John von Neumann. After the war, he joined von Neumann's computer project, working with von Neumann and Deane Montgomery on the inversion of matrices of large dimension.

From 1941 on, Bargmann taught graduate courses at Princeton University, but it was only in 1946 that he obtained a regular appointment as a visiting lecturer in physics. In the following years he worked with E. Wigner on relativistic wave equations. Together they obtained in 1948, the well known Bargmann-Wigner equations for elementary particles of arbitrary spin.

After 1946, apart from one term spent at the University of Pittsburgh in 1948, Bargmann was a member of the Faculty at Princeton. He taught physics and mathematics to generations of graduate and undergraduate students. His lectures were noted for their clarity and polish. However, for connoisseurs of the post-war period, it was the sets of specialized lectures on his own research that were the gems: those on the Lorentz group and its representations of 1948-1949, those on ray representations of Lie

groups of 1953-1954, those on second quantization of 1946-1947.

Bargmann's interests in mathematical physics were broad. As students at the University of Berlin, he and Carl Hempel had a common interest in the philosophical problems at the foundation of physics; an interest they shared with Hans Reichenbach, then Professor at Berlin. The reader of Reichenbach's book *Philosophic Foundations of Quantum Mechanics*, University of California Press, 1944, will see some typical results of conversations with Bargmann, the sharpening and clarification of ideas by the construction of examples and counterexamples.

His contributions to physics led to the creation of several "industries". He demonstrated to everyone's surprise that the one-dimensional Schrödinger equation with two different potentials can have identical phase shifts; scattering data does not suffice to determine a potential. This was one of the starting points of the inverse scattering method. Bargmann also was the first to find upper bounds on the number of bound states in a spherically symmetric potential. Another important topic in the study of the Schrödinger equation is coherent states. Although Bargmann did not invent them (they go back to Schrödinger and many others) he showed that they could be viewed as unitary transformations from the ordinary space of square integrable functions on the line to a space of analytic functions on the complex plane.

Of all Bargmann's papers, the most influential for mathematics was undoubtedly his article on the irreducible unitary representations of the Lorentz group. He found all of them in 1947 and thereby established the paradigm for four decades of effort in representation theory.

In this work he not only classified the representations infinitesimally (i.e. the corresponding representations of the Lie algebra of the Lorentz group), but he constructed these representations globally and explicitly, and divided them into three classes, nowadays known as the "principal series", "discrete series", and "complementary series". In addition, he systematically studied the entry functions of the representations in terms of the differential equations they satisfy, and thereby essentially deduced the "Plancherel formula" for the group.

It is not surprising that he was elected to the National Academy of Sciences in the mathematics section. Bargmann received other honors, such as the Planck medal of the German Physical Society and the Wigner medal, but he was a modest man who sought his satisfaction in his science, his interaction with his friends and his music.

His musical talent was such that he could consider a career as a professional pianist. For many years, he played in small groups delighting his fellow musicians with the depth of his interpretation.

Although Bargmann's writings were influential, his personal influence was even greater. He and Sonja were pillars of the Princeton intellectual community. Our lives will not be the same without them.

Elliot H. Lieb, Elias M. Stein, and Arthur S. Wightman
Princeton University

Alan J. Perlis 1922-1990

Alan J. Perlis, a leader in the development of computer science, died February 7, 1990 at the age of 67.

Professor Perlis, who was Eugene Higgins Professor of Computer Science at Yale University, is probably best known for his work in programming language design. He received his Ph.D. in mathematics from the Massachusetts Institute of Technology in 1950.

From 1952 to 1956, Professor Perlis was a mathematics professor and director of the computer science center at Purdue University, where he developed a digital computer laboratory. He taught at the Carnegie Institute of Technology (now Carnegie-Mellon University) from 1956 to 1971. While there, he founded the graduate department of computer science and helped develop algebraic language compilers and assemblers. He went to Yale in 1971, where he played a leading role in developing Yale's computer science department. His recent areas of research included automatic programming and parallel systems programming.

Professor Perlis was a member of the American Academy of Arts and Sciences and the National Academy of Engineering. He received the A. M. Turing Award from the Association for Computing Machinery in 1966 and the Pioneer Award from the Institute for Electrical and Electronics Engineers in 1985.

Minsky Wins Japan Prize

Marvin L. Minsky, professor of electrical engineering at the Massachusetts Institute of Technology, has received the Japan Prize of \$345,000 for his work in developing and popularizing the concept of artificial intelligence.

Professor Minsky received his Ph.D. in mathematics from Princeton University in 1954. Known for his research in artificial intelligence, the theory of computation, psychology, and engineering, he has been on the MIT faculty since 1958.

The Japan Prize, regarded as the most prestigious scientific honor given in Japan, is awarded each year in two scientific disciplines by the Sci-

ence and Technology Foundation of Japan. The two disciplines for the 1990 awards were technology integration and earth science.

National Academy of Engineering Nominations

The National Academy of Engineering has announced the election of eighty new members and seven foreign associates. Among these are several mathematical scientists: James D. Callen (University of Wisconsin, Madison), Michael L. Dertouzos (Massachusetts Institute of Technology), Alan B. Fowler (IBM Thomas J. Watson Research Center), George J. Gleghorn (TRW Space & Technology Group), Gene H. Golub (Stanford University), Ken Kennedy (Rice University), Alan S. Manne (Stanford University), Bradford W. Parkinson (Stanford University), Ronald L. Rivest (Massachusetts Institute of Technology), David A. Woolhiser (U.S. Department of Agriculture Research Service).

Call for Nominations for Faisal Prize

The General Secretariat of the King Faisal International Prize invites universities and research centers throughout the world to nominate qualified candidates for the King Faisal International Prize in Science, which will be awarded in the field of mathematics in 1991.

The prize consists of a certificate, a gold medal, and 350,000 Saudi Riyals (approximately US \$93,333). The prize, which may be shared by more than one person, will be announced in January, 1991.

Nominations should fulfill the following criteria:

1. The nominee must be living and must have accomplished outstanding work in mathematics, benefiting mankind and enriching human progress.

2. The work submitted must be original and published and must not have been previously awarded a prize by any international organization.

3. Nominations should be from recognized educational institutions. Nominations by individuals or political parties will not be accepted.

4. Nominations should include an official letter on each nominee, indicating the nominated works; a typed CV of the nominee's academic background, experience, and published works; ten copies of the works submitted for nomination; a copy of the nominee's certificates of education; three recent color photos of each nominee, 4 inches by 6 inches; the nominee's full address and telephone number.

5. Nomination papers or works will not be returned to the senders, whether or not the nominee is awarded the prize.

6. The deadline for nominations is **May 10, 1990**.

All correspondence should be sent by registered airmail to: The General Secretariat, King Faisal International Prize, P.O. Box 22476, Riyadh 11495, Kingdom of Saudi Arabia; telephone 4652255; telex 404667 PRIZE SJ; fax 4658685; cable JAEZAH.

In 1987, the King Faisal Prize in Mathematics went to Sir Michael Atiyah, Oxford University.

AMS Journal Wins Award

The *Journal of the American Mathematical Society (JAMS)* has received the 1989 Award for the Best New Journal in Science/Technology/Medicine from the Association of American Publishers (AAP).

Award recipients are selected by a panel of independent judges appointed from the publishing industry and the industrial, medical, and scientific communities by the Professional and Scholarly Publishing Division of AAP. There are two categories for entries, Science/Technology/Medicine and Business/Social Science/Humanities. The panel chose *JAMS* from over 200 professional and scholarly works in the two categories. The award was made on the basis of all-around excellence, in-

cluding such criteria as content and design.

JAMS is edited by Michael Artin, H. Blaine Lawson, Jr., Richard Melrose, Wilfried Schmid, and Robert E. Tarjan. Those responsible for *JAMS* in the AMS office in Providence include the production editor, Arlene O'Sean, as well as the keyboarding, T_EX-support, and printing staff.

Woolf Joins Providence Staff

William B. Woolf has left his position as Managing Editor of *Mathematical Reviews (MR)* to become an Associate Executive Director of the AMS in Providence. He will be in charge of computing services for the Society.

Woolf received his Ph.D. in mathematics from the University of Michigan in 1959. He served on the mathematics faculty at the University of Washington, advancing to the rank of associate professor before taking a position as Associate Secretary and Director of Administration of the American Association of University Professors in Washington, DC. In 1979 he moved to *MR* as Managing Editor. His former *MR* duties not involving computing services will be assumed by *MR* Associate Executive Editor Jane Kister.

In his new position with the AMS, Woolf will oversee the Computer Services Division of the Society, which has been expanded to include the *MR* Systems Department in Ann Arbor. AMS computing activities include computer typesetting for all AMS publications, membership and sales databases, the *MR* database, the fiscal system, and routine office administration. In addition, he will be in charge of an AMS electronic communications project that will build on the Internet electronic network to produce a complete information-exchange system tailored to the needs of the mathematical sciences community. The yet-to-be-named system will provide access to electronic addresses, conferencing and bulletin board facilities, document delivery,

and electronic book ordering and meetings registration.

NSF Regional Geometry Institute

During the next three summers, the Department of Mathematics at Boston University will host a Regional Institute in Dynamical Systems (RIDS). Funded by the National Science Foundation as part of its Regional Geometry Institutes Program, RIDS will bring together researchers, college and secondary teachers, graduate and high school students, to study a range of topics in dynamics.

RIDS begins with a two-week intensive short course on the Geometric Theory of Dynamical Systems, to be held July 16-27, 1990, at Boston University. Topics will include chaotic dynamics, complex dynamics, circle and annulus maps, symbolic dynamics, and pedagogical issues. Boston University mathematics faculty members Paul Blanchard, Robert L. Devaney, David Fried, and G. R. Hall will present the lectures.

The short course will prepare participants for the more advanced research lectures in the main part of RIDS, to be held during the summers of 1991 and 1992 at Boston University. The sessions will consist of a series of week-long conferences each featuring one or two leading experts who will speak on such topics as: renormalization and rigidity, chaotic dynamics, twist maps, attractors, computational complexity theory, fractal geometry, complex analytic dynamics, and surface dynamics and neural networks.

A major focus of RIDS will be coordination with several ongoing programs which combine dynamics and educational issues, including programs for high school students and teachers. Each plenary speaker will deliver a lecture aimed at introducing high school students to her or his research specialty. Other invited lecturers will discuss the teaching of dynamical systems at all levels.

It is anticipated that the National Science Foundation will provide travel and lodging expenses for RIDS participants. Graduate students, women, and members of underrepresented minorities are encouraged to apply for support. For more information, write to: Regional Institute in Dynamical Systems, Department of Mathematics, Boston University, 111 Cummington Street, Boston, MA 02215; or send electronic mail to dyn-inst@math.bu.edu.

New Association Launched in France

The Henri Poincaré Association for the History and Philosophy of Mathematics and Physics was created in July, 1989 to promote relations among mathematicians, physicists, and historians and philosophers of science. The activities of the Association primarily focus on studies of the nineteenth and twentieth centuries and seek to define the specific role that history and philosophy can play in the practice of science.

For the 1989-1990 year, the Association sent out to its membership three informational letters and organized a number of activities associated with the various themes currently being developed at the Henri Poincaré Institute in Paris.

Those on the governing committee of the Association are: Michel Blay, Jean-Luc Chabert, Karine Chemla, Thierry Coulhon, Catherine Chevalley, Amy Dahan-Dalmedico, Olivier Darrigol, Dominique Pestre, Hourya Sinaceur, Dominique Pestre, for the Association. Membership dues for the Association are 100 FF. For more information, write to the Association at this address: l'Institut Henri Poincaré, 11, rue P. et M. Curie, 75005 Paris, France.

Science Visuals for CBS News Sought

The Scientists' Institute for Public Information (SIPI) is seeking assistance from the scientific and mathematical communities to provide vi-

sual materials for use on network and local news programs.

SIPI runs a Videotape Referral Service for news directors, producers, and reporters who are seeking reliable sources of quality science footage for use on television news. As a result of the success of the service, CBS News has asked SIPI for assistance in producing a weekly, 30-second spot for the evening news. The segment, narrated by anchorman Dan Rather, will focus on interesting, cutting-edge developments in the world of science and technology.

To improve television coverage of the sciences SIPI would appreciate receiving quality videotapes, films, slides, or photographs of current, exciting research occurring in universities throughout the country. Contributing to this project will help to enhance public understanding of the importance, fascination, and utility of research in science and mathematics.

If you have materials you would like to submit, or if you would like more information about the Science & TV Project or other SIPI programs, call Lara Trubowitz or Joyce Gramza at 212-661-9110, or write to SIPI at 355 Lexington Avenue, New York, NY 10017.

SIPI is a national, non-profit organization dedicated to improving public understanding of science and technology by bridging the gap between science and the media.

"Math is Radical" Program

A program designed to improve the mathematics skills of high school students and offer teachers a tool for enhancing mathematics teaching in the classroom has been developed by MathSoft, Inc., in conjunction with the National Council of Teachers of Mathematics (NCTM). Congressional representatives and state departments of education were also involved in announcing the availability of the program entitled "Math is Radical".

MathSoft is donating a retail value of \$3 million of software to U.S. high schools and has developed materials to support "Math is Radical." The NCTM has recognized the program as assisting efforts to implement the curriculum and evaluation standards which it set forth last year. To date, 180 high schools are participating in the first year of the program.

Each participating school receives a "Math is Radical" package, including MathCAD for IBM PCs or compatibles, or for Apple Macintosh computers and classroom teaching tools for MathCAD. Tutorials and templates for curriculum development at the algebra, pre-calculus, and calculus levels are included. There will also be a "Math is Radical" contest, in which students submit solutions to mathematical problems which the students themselves have formulated.

Sponsors for

JPBM Communications Award

The Joint Policy Board for Mathematics (JPBM) wishes to thank the following companies, which co-sponsored the second JPBM Communications Award and the reception in honor of its recipient, Hugh Whitmore, at the Joint Mathematics Meetings in Louisville (see February 1990 *Notices*, page 139):

Academic Press, Inc.

The Benjamin/Cummings Publishing Company, Inc.

Brooks/Cole Publishing Company

John Wiley & Sons

Springer-Verlag New York, Inc.

Workshop for College Faculty

Using Graphing Calculators and Computer Graphing to Enhance the Teaching and Learning of Precalculus Mathematics and Calculus. August 12-13, 1990. Holiday Inn, Columbus. No registration fee. \$100 partial travel expense awards from Addison-Wesley. For application: F. Demana and B. Waits, Dept. of Math., The Ohio State Univ., 231 W. 18th Avenue, Columbus, Ohio 43210.

Funding Information for the Mathematical Sciences

1991-1992 Fulbright Competition Opens

The United States Information Agency, the Board of Foreign Scholars, and the Institute of International Education announce the official opening on May 1, 1990 of the 1991-1992 competition for Fulbright grants.

These grants support graduate study or research abroad in academic fields. Also available are travel-only grants to selected countries to supplement maintenance awards from another source that do not provide funds for international travel or to supplement the applicant's personal funds.

Applicants must be U.S. citizens at the time of application and hold a bachelor's degree or its equivalent by the beginning date of the grant. They also must possess sufficient proficiency in the language of the host country to carry out the proposed study or research.

Fulbright grants provide round-trip international travel, maintenance for the tenure of the grant, and tuition waivers, if applicable. Travel grants provide round-trip travel to the country where the student will

pursue study or research. All grants include basic health and accident insurance.

Students currently enrolled in a college or university should contact their on-campus Fulbright Program Adviser for brochures, application forms, and further information. At-large applicants should contact the U.S. Student Programs Division at the Institute for International Education, 809 United Nations Plaza, New York, NY 10017; telephone 212-984-5327. Fulbright Program Advisers establish campus deadlines. At-large applicants must submit their completed applications to the U.S. Student Programs Division at the above address by **October 31, 1990**.

Landahl Travel Awards

The Society for Mathematical Biology (SMB) has funds for partial support of the travel of graduate students to meetings co-sponsored by SMB, including the SIAM Meeting in Chicago (July 16-20), and the International Union for Pure and Applied Biophysics (IUPAB) Meeting in Vancouver, Canada (July 29 - August 3,

1990). (See page 488 in this issue of *Notices* for an announcement of this meeting.)

Graduate students who wish support may apply to: Michael C. Reed, Department of Mathematics, Duke University, Durham, NC 27706. The application, which should be received by **May 25, 1990**, should include a one-page research summary and a letter from a faculty sponsor.

Notice of Deadline Change

The National Science Foundation has changed the deadline for its undergraduate course curriculum development program from April 9, 1990 to **October 15, 1990**. The program was described in "NSF Expands Curriculum Development," in the February Information section of the February 1990 issue of *Notices*, page 145. The program addresses curriculum development for courses other than calculus; therefore, the deadline change will not affect the calculus curriculum development program, which will likely have a deadline of February 1, 1991.

1990 AMS Elections

Nominations by Petition

Vice-President or Member-at-Large

One position of vice-president and member of the Council ex officio for a term of two years is to be filled in the election of 1990. The Council intends to nominate two candidates, whose names may be expected to appear in the June issue of *Notices*, which is scheduled to be mailed by the printer on 23 May. Nominations by petition as described in the rules and procedures are acceptable.

Five positions of member-at-large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate seven candidates, whose names may be expected to appear in the June *Notices*. Nominations by petition in the manner described in the rules and procedures are acceptable. The Council has stated its intent to have at least ten candidates and will bring the number up to ten if the nominations by petition do not do so.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions.

Prior to presentation to the Council, petitions in aid of a candidate for the position of vice-president or of member-at-large of the Council must have at least 50 valid signatures and must conform to several rules and operational considerations, which are described below.

Editorial Boards Committee

Two places on the Editorial Boards Committee will be filled by election. There will be four continuing members of the Editorial Boards Committee, namely:

Linda Keen

Carlos Kenig

Barry Simon

Daniel Zelinsky

The new members will be elected in a preferential ballot. The President will name three candidates for these two places. The names may be expected to appear in the June issue of *Notices*. Nominations by petition, in the manner described in the rules and procedures, will be accepted. Should the final number of candidates be less than four, the President will bring it up to four.

The name of a candidate for member of the Editorial Boards Committee may be placed on the ballot by petition. The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

Nominating Committee

Three places on the Nominating Committee will be filled by election. There will be seven continuing members of the Nominating Committee, namely:

Joan S. Birman

James E. Humphreys

Barbara Lee Keyfitz

Victor Klee

Ray A. Kunze

Alan D. Weinstein

Robert F. Williams

The new members will be elected in a preferential ballot. The President will name five candidates for these three places. The names may be expected to appear in the June issue of *Notices*. Nominations by petition, in the manner described in the rules and procedures, will be accepted. Should the final number of candidates be less than six, the President will bring it up to six.

The name of a candidate for member of the Nominating Committee may be placed on the ballot by petition. The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

Rules and Procedures

Use separate copies of the form for each candidate for vice-president, member-at-large, or member of the Nominating and Editorial Boards Committees.

1. To be considered, petitions must be addressed to Robert M. Fossum, Secretary, P.O. Box 6248, Providence, Rhode Island 02940, and must arrive by 6 July 1990.

2. The name of the candidate must be given as it appears in the *Combined Membership List*. If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the *Notices*. If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate's mailing label or the Providence office.

3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.

4. On the next page is a sample form for petitions. Copies may be obtained from the Secretary; however, petitioners may make and use photocopies or reasonable facsimiles.

5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.

6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the *Combined Membership List* and the mailing lists. No attempt will be made to match variants of names with the form of name in the CML. A name neither in the CML nor on the mailing lists is not that of a member. (Example: The name Robert M. Fossum is that of a member. The name R. Fossum appears not to be.)

7. When a petition meeting these various requirements appears, the Secretary will ask the candidate whether he is willing to have his name on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving his consent.

NOMINATION PETITION FOR 1990 ELECTION

The undersigned members of the American Mathematical Society propose the name of

_____ as a candidate for the position of (check one):

- ☐ **Vice-President**
- ☐ **Member-at-Large of the Council**
- ☐ **Member of the Nominating Committee**
- ☐ **Member of the Editorial Boards Committee**

of the American Mathematical Society for a term beginning 1 January, 1991.

Name and Address (printed or typed)

Signature

Signature

Signature

Signature

Signature

Signature

Columbus Meetings August 8 – 11, 1990

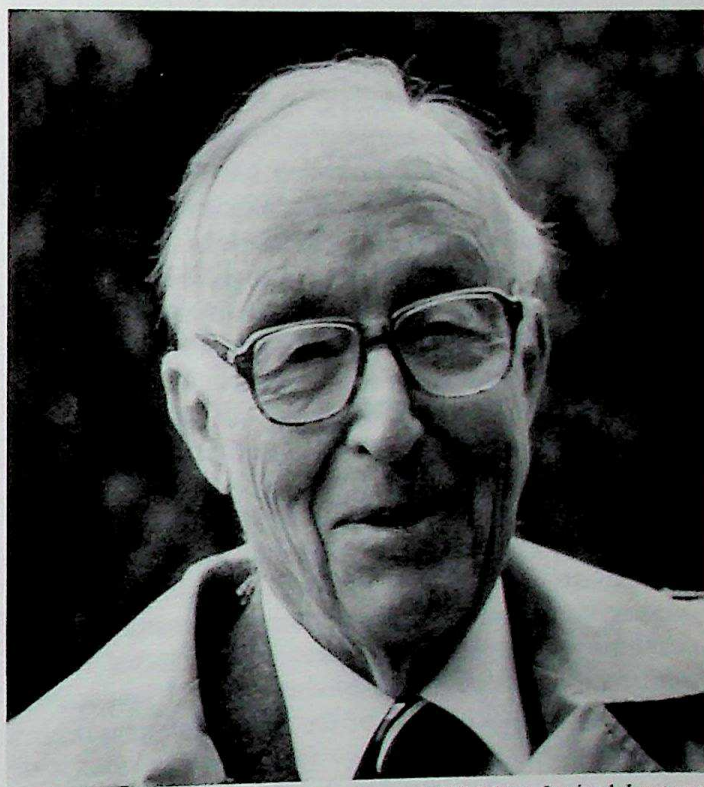
Preliminary Announcement

The Scientific Program

The August 1990 Joint Mathematics Meetings, including the 93rd Summer Meeting of the AMS, the 69th Summer Meeting of the Mathematical Association of America and the celebration of the 75th Anniversary of the founding of the MAA, and the 1990 summer meetings of the Association for Women in Mathematics and Pi Mu Epsilon, will be held August 8 – 11 (Wednesday – Saturday), 1990, at The Ohio State University, Columbus, Ohio. Sessions will take place on the campus of the university and the Holiday Inn.

AMS-MAA Invited Address

The Society, on the occasion of the MAA's 75th Anniversary, will cosponsor an invited address by SAUNDERS MAC LANE, University of Chicago, on *Algebra as a means of understanding mathematics*, at 9:55 a.m. Thursday, August 9.



Saunders Mac Lane, AMS-MAA Invited Lecturer

IMPORTANT DEADLINES

AMS Abstracts	
For Consideration for Special Sessions	April 27
Of Contributed Papers	May 18
MAA Poster Session Presentations	May 1
Nominations for MAA Undergraduate Student Papers	
MAA Abstracts	May 15
Of Contributed Papers	
Summer List of Applicants	May 18
ORDINARY Preregistration and Housing	June 6
MAA Minicourse Preregistration	June 6
Motions for AMS Business Meeting	June 6
FINAL Preregistration	July 10
Housing Changes and Cancellations with Housing Bureau	July 11
Residence Hall Package Cancellation (90% refund)	July 16
MAA Banquet (50% refund)	July 16
Sock Hop (50% refund)	July 31
π μ ϵ Banquet (50% refund)	July 31
Other Changes to Preregistration	July 31
Preregistration Cancellations (50% refund)	August 3

WHERE TO FIND IT

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93rd Summer Meeting of the AMS

August 8 - 11, 1990

Progress in Mathematics Lectures: This series of lectures provides a forum for the exposition of mathematical topics that have come into prominence in the past five years. The members of the Progress in Mathematics Selection Committee for these lectures are Armand Borel (chairman), Paul H. Rabinowitz, Hugo Rossi, John T. Tate, and Alan Weinstein.

The names and affiliations of the speakers, their titles, and the days and times they will talk are as follows:

JOHN W. MORGAN, Columbia University, *A-trees and their applications*, 3:35 p.m. Saturday.

MICHAEL G. CRANDALL, University of California, Santa Barbara, *Viscosity solutions of partial differential equations*, 3:35 p.m. Thursday.

Prizes: The 1990 Leroy P. Steele Prizes and the Norbert Wiener Prize in Applied Mathematics will be awarded at 11:05 a.m. on Friday, August 10.

Invited Addresses: By invitation of the AMS Program Committee for National Meetings, there will be two fifty-minute invited addresses. The names and affiliations of the speakers, their titles, and the days and times they will talk are as follows:

JOSEPH G. CONLON, University of Michigan, Ann Arbor, *Statistical mechanics of Coulomb systems*, 9:55 a.m. Friday.

MICHAEL E. TAYLOR, University of North Carolina, Chapel Hill, *The role of microlocal analysis in PDE*, 8:50 a.m. Friday.

Special Sessions: By invitation of the same committee, there will be six special sessions of selected twenty-minute papers. The topics of these special sessions and the names and affiliations of the mathematicians arranging them are:

Combinatorics, THOMAS A. DOWLING, DIJEN RAY-CHAUDHURI, and NEIL ROBERTSON, The Ohio State University.

Algebraic geometry, SUSAN JANE COLLEY and GARY KENNEDY, Oberlin College.

Dynamics of biological systems, ZITA M. DIVIS and DAVID TERMAN, The Ohio State University.

Ring theory, S. K. JAIN, Ohio University, and S. TARIQ RIZVI, The Ohio State University.

Combinatorial games, RICHARD K. GUY, University of Calgary, and RICHARD J. NOWAKOWSKI, Dalhousie University.

Group theory, SURINDER K. SEHGAL and RONALD SOLOMON, The Ohio State University.

Most of the papers to be presented at these special sessions will be by invitation; however, anyone contributing an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these sessions should indicate this clearly on the abstract, and

should submit it by April 27, 1990, three weeks earlier than the normal deadline for contributed papers, in order that it be considered for inclusion.

Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940. A charge of \$16 is imposed for retyping abstracts that are not in camera-ready form.

Contributed Papers: There will be sessions for contributed papers Thursday morning, Friday morning and afternoon, and Saturday morning and afternoon.

Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, so as to arrive by the abstract deadline of May 18, 1990. A charge of \$16 is imposed for retyping abstracts that are not in camera-ready form.

Late papers will not be accepted.

Electronic Submission of Abstracts: This service is now available to those who use the TeX typesetting system and can be used for abstracts of papers to be presented at this meeting. Requests to obtain the package of files may be sent by electronic mail on the Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Secretary to Director of Publications, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940. When requesting the Abstracts package, users should be sure to specify whether they want the plain TeX, AMS-TeX, or the L^AT_EX package. Again, late papers will not be accepted.

AMS Committee on Science Policy: A panel discussion sponsored by the AMS Committee on Science Policy is scheduled for Friday, August 10, at 8:00 p.m.

Other AMS Events

Council Meeting: The Council of the Society will meet at 2:00 p.m. on Tuesday, August 7.

Business Meeting: The Business Meeting of the Society will take place immediately following the award of the Steele and Wiener Prizes at 11:05 a.m. on Friday, August 10. The secretary notes the following resolutions of the Council: Each person who attends a Business Meeting of the Society shall be willing and able to identify himself as a member of the Society. In further explanation, it is noted that each person who is to vote at a meeting is thereby identifying himself as and claiming to be a member of the American Mathematical Society.

For additional information on the Business Meeting, please refer to the box titled Committee on the Agenda for Business Meetings.

Other AMS - MAA Joint Sessions

Evening of Dialogue on Mathematics Education: On Thursday, August 9, the AMS, MAA and Mathematical Sciences Education Board are cosponsoring several events, beginning at 6:30 p.m. with a gala reception for all participants. The reception will be followed at 7:30 p.m. by a session on *Mathematics education*. ELAINE HARISTON, Acting Chancellor, Ohio Board of Regents, will preside and will introduce the main speaker for the evening. LIDA K. BARRETT, President of the MAA, and WILLIAM BROWDER, President of the AMS, will act as respondents.

MAA 75th Anniversary

69th Summer Meeting

August 8 - 11, 1990

The founding of the MAA: Had one vote been cast differently, we would not be celebrating in August of 1990 the 75th Anniversary of the Mathematical Association of America. There probably would have been no MAA. It all started in 1894 when Benjamin Finkel, who had taught high school in Ohio and Tennessee, started publishing *The American Mathematical Monthly*, aimed primarily at a high school audience, but subsequently expanded to include undergraduates and their teachers. Finkel, who later taught at Drury College in Missouri, solicited for his enterprise some distinguished university faculty: G. B. Halsted of Texas, E. H. Moore of Chicago, and W. E. Byerly of Harvard. The first issue contained an article by Leonard Eugene Dickson, then a 19-year-old graduate student at Texas. Eventually he persuaded Dickson (by then at Chicago) and Herbert Ellsworth Slaught at Chicago to become associate editors, along with G. A. Miller of the University of Illinois. The *Monthly* continued to appear, though on a rather shaky financial foundation, until 1912, when additional support was obtained from a number of other colleges and universities, primarily in the Midwest.

In an attempt to arrange for more stable and permanent support for the *Monthly*, Slaught proposed assistance from the American Mathematical Society, which was noted in the minutes of the Council "a communication from Professor Slaught suggesting the appointment by the Council of a Committee to consider the general relation of the Society to the promotion of teaching, especially in the collegiate field." Such a committee was appointed and consisted of Thomas Scott Fiske, Henry Burchard Fine, Earle Raymond Hedrick, William Fogg Osgood and Slaught.

At the April 1915 meeting of the Council, the Committee reported that by a vote of three to two it had decided to recommend that the American Mathematical Society "should not undertake nor become responsible for the publication of the *Monthly*", a decision in which the Council concurred. It is interesting to note, however, that the Council did adopt the following resolution: "It is deemed unwise for the American Mathematical Society to enter into the activities of the special field now covered by the *American Mathematical Monthly*; but the Council desires to express its realization of the importance of the work in this field and its value to mathematical science, and to say that should an organization be formed to deal specifically with this work, the Society would entertain toward such an organization only feelings of hearty good will and encouragement."

So with the committee vote and the decision of the Council to accept the committee's recommendation, the stage was set for the forming of a new organization to provide a home for the *Monthly*. Slaught sent out a letter soliciting interest in a new organization and a surprising 450, representing every state in the Union, the District of Columbia and Canada, responded by signing the call to an organizational meeting.

The meeting was held in Room 101, Page Hall, on the campus of The Ohio State University in Columbus, December 30-31, 1915. The setting was a meeting of the American Association for the Advancement of Science (AAAS). Slaught delivered the opening remarks. He talked about the history of the *Monthly* and "emphasized the fact that this journal had stood consistently, since its reorganization, for advancing the interests of mathematics in the collegiate and advanced secondary fields, and expressed the hope that the new organization might carry forward these aims with still greater effectiveness, cooperating, on the one hand, with the various well-organized secondary associations, and the other hand, with the American Mathematical Society in its chosen field of scientific research, but being careful to encroach upon neither of these fields."

Hedrick presided at the meeting. There were 104 people attending, of whom 49 were from large universities, 43 from mainly undergraduate institutions, and six from high schools. W. D. Cairns of Oberlin College was the temporary secretary. All the business of organizing the Association was completed in one three-hour session, except for one difficult issue: the choice of a name. That took a committee of three to sort through eighteen proposals. The choice of "Mathematical Association of America" was unanimous.

Hedrick was chosen as the first President, E. V. Huntington of Harvard and G. A. Miller of Illinois as Vice Presidents, and Cairns as Secretary-Treasurer. Hedrick later became the 20th President of the American

Mathematical Society (1929-1930). Cairns was to serve as Secretary-Treasurer until 1943, a record for the position, but not a match for the record of Finkel, who served for 19 years as Editor of the *Monthly* and another 21 years as Associate Editor. Cairns became President of the MAA in 1943.

There was no formal program for that first meeting, but L.C. Karpinski of the University of Michigan gave an illustrated lecture on "The Story of Algebra." Cairns reported that "it is not too much to say that for the space of an hour he both charmed and edified an enthusiastic audience of approximately one hundred persons."

Three sections had been organized prior to the December meeting in Columbus, those of Kansas, Missouri, and Ohio. Clearly the sectional structure of the Association was not an afterthought.

Founded at the beginning of the First World War, the Association claimed 1100 members by the end of the war three years later. In 1920 the MAA was incorporated in the State of Illinois.

The issues before the Association in the days before and shortly after its founding do not sound much different from many of the issues today. Should a course in mathematics be required for graduation? Should calculus be taught in the freshman year? (W. F. Osgood thought that it should be.) Should the United States go on the metric system? Should the same course be taught to future mathematicians and scientists as to other students? Should separate courses in different areas be taught, or should they be replaced by an integrated course? Committees were formed to study these questions

and reports were duly submitted and distributed.

The Association has come a long way from the three sections and the 104 people attending the organizational meeting in Columbus to 29 sections with almost 28,000 members today. With the publication of three journals, a newsletter, and a number of series of books and monographs, along with national and sectional meetings and many other activities, the Association is a widely felt force in mathematics and mathematics education.

The 75th Anniversary Celebration: To celebrate the 75th Anniversary of the founding of MAA, the Joint Mathematics Meetings are being held on The Ohio State University campus.

The first day of the meeting, MAA Day, will be devoted entirely to activities of the Association. Not even committee meetings will be scheduled that day. The day will begin with Opening Ceremonies. The first invited address will be given by G. BALEY PRICE, University of Kansas, Past President of the MAA (1957-1958), who has been active in the MAA for over fifty years. A short ceremony will follow marking the installation of two plaques, one outside room 101 of Page Hall (the very room where the MAA was organized in 1915) and the other near the office of the Department of Mathematics. All those attending the meetings are invited to visit Page Hall and the mathematics offices to see the actual settings of these commemorative plaques. The morning will be completed with an invited address by JUDITH V. GRABINER, Pitzer College, who is a noted historian of mathematics.



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In the early afternoon four major thirty-minute addresses will be given by WADE ELLIS, JR., West Valley College; PAUL R. HALMOS, Santa Clara University; PETER J. HILTON, State University of New York at Binghamton; and CATHLEEN S. MORAWETZ, Courant Institute of Mathematical Sciences at New York University. A mathematical circus and group picture taking round out the afternoon.

The program for the remaining three days will more resemble the usual Joint Mathematics Meeting, but with some special features. There will be ten Joint Invited Addresses, each jointly sponsored by the MAA and one other organization. The ten cosponsoring organizations (listed in order of founding) are the American Association for the Advancement of Science (AAAS), the American Mathematical Society (AMS), Pi Mu Epsilon, Inc. (PME), National Council of Teachers of Mathematics (NCTM), Canadian Mathematical Society (CMS), Association for Computing Machinery (ACM), Society for Industrial and Applied Mathematics (SIAM), National Association of Mathematicians (NAM), Association for Women in Mathematics (AWM), and American Mathematical Association of Two-Year Colleges (AMATYC).

The Earle Raymond Hedrick Lectures will be given by PHILIP J. DAVIS, Brown University. HELAMAN FERGUSON, mathematical sculptor, will make a thirty-minute presentation on the morning of August 9.

The Program Committee coincides with the Committee on the 75th Anniversary: GERALD L. ALEXANDERSON (chair), DAVID W. BALLEW, LEONARD GILLMAN, IVAN

NIVEN, EILEEN L. POIANI, G. BALEY PRICE, JOHN O. RIEDL, KENNETH A. ROSS, MARCIA P. SWARD (ex officio), and ALFRED B. WILLCOX (ex officio).

MAA DAY, August 8, 1990: The Opening Ceremonies will take place from 8:30 a.m. to 9:30 a.m. The First Invited Address will be given by G. BALEY PRICE, University of Kansas, at 9:55 a.m. The title of his address is *The Seventy-Fifth Anniversary Celebration*. At 10:55 a.m. there will be a brief ceremony in Mershon Auditorium marking the dedication of a plaque installed at the site where the MAA was organized in December 1915. The Second Invited Address will be given by JUDITH V. GRABINER, Pitzer College, at 11:10 a.m. and is titled *Was Newton's calculus just a dead end? Maclaurin and the Scottish connection*.

Beginning at 1:30 p.m. there will be four major thirty-minute addresses as follows: WADE ELLIS, JR., West Valley College, will speak at 1:30 p.m. on *Mathematics and computation: Proliferation and fragmentation*. PAUL R. HALMOS, Santa Clara University, will speak at 2:10 p.m. on *Has progress in mathematics slowed down?* PETER J. HILTON, State University of New York at Binghamton, will speak at 2:50 p.m. on *The contribution of mathematics to education*. CATHLEEN S. MORAWETZ, Courant Institute for Mathematical Sciences at New York University, will lecture on *The last 75 years: Giants of applied mathematics* at 3:30 p.m.

There will be a mathematical circus emphasizing juggling and magic from 4:45 p.m. to 5:45 p.m. Just



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Mershon Auditorium, site of MAA Day Activities

prior to this, at 4:15 p.m., an historic group picture will be taken. All participants are warmly invited to gather in the Mirror Lake Hollow Amphitheater. A student reception is scheduled from 6:00 p.m. to 7:00 p.m. and a banquet open to all participants will be held in the evening beginning at 7:00 p.m. See the section on **Social Events** for more details.

Hedrick Lectures: The 38th Earle Raymond Hedrick Lectures will be given by PHILIP J. DAVIS of Brown University. These lectures are scheduled from 1:15 p.m. to 2:15 p.m. on Thursday, Friday, and Saturday, August 9-11. The series of lectures is titled *Spirals from Theodorus of Cyrene to meta-chaos*. The first lecture is titled *Spirals: Old and new*; the second is titled *Lessons from Euler*; and the third is titled *Theodorus goes wild*.

Other MAA Talks: ARTHUR BENJAMIN of Harvey Mudd College will give a special lecture at 4:30 p.m. on Thursday, August 9, on *The art of mental calculation*. Benjamin is noted for his extraordinary ability to do complicated calculations without any external memory aids like pencil and paper. HELAMAN FERGUSON, Supercomputing Research Center, will give a thirty-minute presentation on sculpturing at 8:00 a.m. on Thursday, August 9.

Joint Invited Addresses: As a special feature of the 75th Anniversary Celebration, there will be ten joint invited fifty-minute addresses as follows:

AAAS-MAA Address: RICHARD ASKEY, University of Wisconsin, Madison, *Lost and found mathematics*, 8:50 a.m., Thursday.

AMS-MAA Address: SAUNDERS MAC LANE, University of Chicago, *Algebra as a means of understanding mathematics*, 9:55 a.m., Thursday.

MAA-NCTM Address: JOHN A. DOSSEY, Illinois State University, *Mathematics education - yesterday, today, and tomorrow*, 11:00 a.m., Thursday.

MAA-PME Address: IVAN NIVEN, University of Oregon, *Problems for all seasons*, 2:30 p.m., Thursday.

CMS-MAA Address: PAULO RIBENBOIM, Queen's University, *Prime number records*, 2:30 p.m., Friday.

MAA-SIAM Address: RICHARD TAPIA, Rice University, *Interior point methods for linear programming: An overview*, 3:35 p.m., Friday.

ACM-MAA Address: JURIS HARTMANIS, Cornell University, *On the computational complexity of doing mathematics*, 8:50 a.m., Saturday.

MAA-NAM Address: CARL PRATHER, Virginia Polytechnic Institute and State University, *Intriguing problems about zeros in complex analysis*, 9:55 a.m., Saturday.

AWM-MAA Address: JUDITH ROITMAN, University of Kansas, *The uses of set theory*, 11:00 a.m., Saturday.

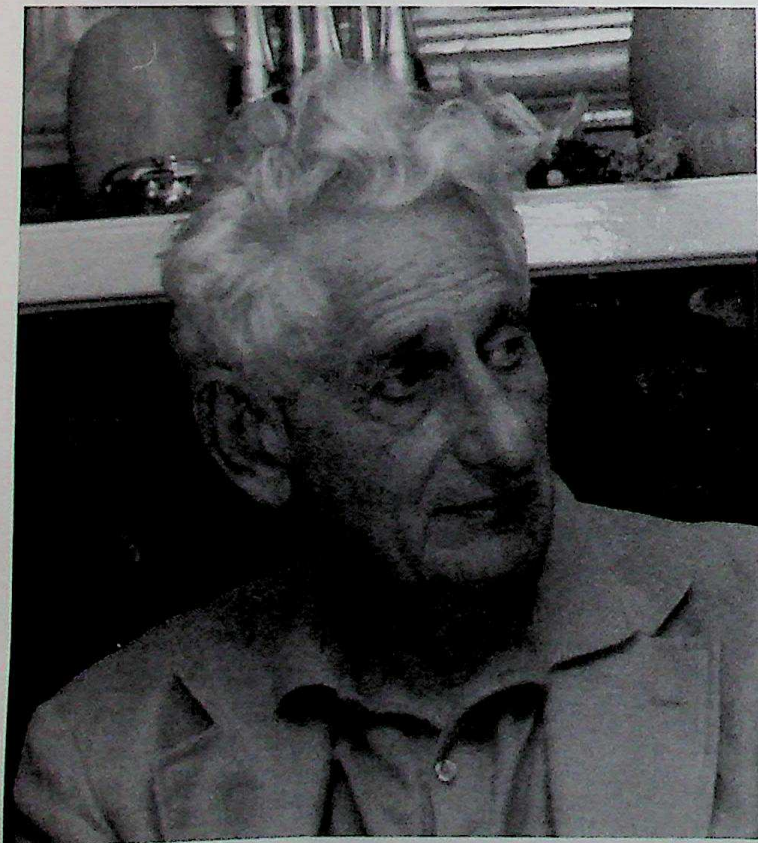
AMATYC-MAA Address: KARL J. SMITH, Santa Rosa Junior College, *Crisis in mathematics education: perspective from the two-year college*, 2:30 p.m., Saturday.

Abbreviations above are as follows: AAAS = American Association for the Advancement of Science; AMS = American Mathematical Society; PME = Pi Mu Epsilon, Inc.; NCTM = National Council of Teachers of Mathematics; CMS = Canadian Mathematical Society; ACM = Association for Computing Machinery; SIAM = Society for Industrial and Applied Mathematics; NAM = National Association of Mathematicians; AWM = Association for Women in Mathematics; AMATYC = American Mathematical Association of Two-Year Colleges. These organizations are listed in the order of their age; AAAS is oldest and AMATYC is youngest.

Minicourses: Thirteen Minicourses are being offered by the MAA. The names and affiliations of the organizers, the topics, the dates and times of their meetings, and the enrollment limitations of each are as follows:

Minicourse #1: *Using metacognitive strategies to improve instruction* is being organized by GENEVIEVE KNIGHT, Coppin State College. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Thursday, August 9, and Part B from 2:30 p.m. to 4:30 p.m. on Thursday, August 9. Enrollment is limited to 30.

Are your students using efficient and effective methods to attack exercises and problem situations? If not, why not? Given similar or new situations, students are often unable to implement previously learned knowledge, tools, and strategies in finding results. Missing for the students is the holistic approach of understanding the structure of mathematics and how they intake, process, transfer, and use information. Perhaps the answers lie within



Philip J. Davis, Hedrick Lecturer

cognitive science. Metacognition instructional strategies and techniques enable professors to assist their students in becoming critical thinkers and problem solvers. Using an interactive mode, the organizer will demonstrate strategies, embedded in a metacognitive framework, that will assist students in shaping their learning and thinking styles. The course will include i) background information in metacognition and critical thinking and ii) mathematical exercises and examples generated from algebra, trigonometry, analytic geometry and calculus.

Minicourse #2: Planning, funding, and administering teacher enhancement projects is being organized by T. CHRISTINE STEVENS, St. Louis University. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Thursday, August 9, and Part B from 2:30 p.m. to 4:30 p.m. on Thursday, August 9. Enrollment is limited to 30.

Increasingly, mathematicians are being called upon to join in the national effort to improve the quality of precollege education in mathematics. One way in which mathematicians can become involved is through teacher enhancement programs. These programs provide in-service education for precollege teachers, often through summer workshops. Federal funding is available to support many of these programs. This Minicourse will focus on questions such as: How do we plan a teacher enhancement project? How do we develop contacts and initiate interactions with the schools? What funding sources are available? How do we prepare a persuasive funding proposal? Participants will hear presentations by successful project directors and by a current or former program officer of a funding agency. Some hands-on activities in the art of proposal preparation will be included.

Minicourse #3: A seminar on women in mathematics is being organized by MIRIAM P. COONEY CSC, Saint Mary's College. Part A is scheduled from 10:15 a.m. to 12:15 p.m. on Thursday, August 9, and Part B from 4:45 p.m. to 6:45 p.m. on Thursday, August 9. Enrollment is limited to 30.

The goal of this Minicourse is to prepare participants to conduct a seminar that identifies women mathematicians (past and present), studies their lives and the mathematical times as a context for their work, and reveals mathematics as a human pursuit. The content of the Minicourse, like the seminar, will include the history of women mathematicians, gender bias and its historic causes, research on gender differences, alternative teaching/learning styles, and recent research on "women's ways of knowing." Assuming that social-emotional aspects of learning are important to students of mathematics, the Minicourse will provide strategies for creating a seminar that provides a support group to encourage potential mathematics majors, both women and men. The format will follow seminar-style discussions, including consideration of "process" as a mode

of teaching. Readings and a syllabus with an extensive bibliography will be sent to participants prior to the meeting.

Minicourse #4: A calculus laboratory using Mathematica is being organized by MICHAEL BARRY, BENJAMIN HAYTOCK and RICHARD McDERMOT, Allegheny College. Part A is scheduled from 10:15 a.m. to 12:15 p.m. on Thursday, August 9, and Part B from 4:45 p.m. to 6:45 p.m. on Thursday, August 9. Enrollment is limited to 30.

The development of easy-to-use computer software with two and three-dimensional graphics and symbolic manipulation capabilities is leading to fundamental changes in the way we teach, and the way students learn, undergraduate mathematics. One of the most powerful of these software systems is *Mathematica*, developed by Wolfram Research, Inc. under the direction of Stephen Wolfram. In this Minicourse participants will receive hands-on instruction in the use of *Mathematica* on the NeXT computer and in the ways that *Mathematica* and similar software systems can be used to enhance the student's understanding of calculus concepts. Attention will also be given to techniques for the development of applications packages and on-line textbook modules using the *Mathematica Notebook Facility*, and to comparisons of the features of different versions of *Mathematica* and of other graphics and symbolic systems. No prior experience with computers is required.

Minicourse #5: Using history in teaching calculus is being organized by V. FREDERICK RICKEY, Bowling Green State University and on leave at U.S. Military Academy. Part A is scheduled from 10:15 a.m. to 12:15 p.m. on Thursday, August 9, and Part B from 4:45 p.m. to 6:45 p.m. on Thursday, August 9. Enrollment is limited to 80.

Students of the calculus instinctively ask many penetrating questions: What is the calculus? What good is it? Why are the concepts presented the way they are? As the calculus reform movement eliminates the computational drudgery to concentrate on the fundamental ideas of the calculus, it will be even more imperative to respond to these questions. The answers are inherently historical, and so by interjecting a historical vein into our teaching we can respond to these questions in meaningful and inspiring ways. A wide variety of ideas for using the history of the calculus that have been successfully used to motivate students will be presented. Some samples: The geographical origins of the integral of the secant, an idea of Fermat for integrating x^n , a trick of Euler's for max-min problems, and how an analysis of a wrong proof of Cauchy leads to the definition of uniform convergence. Bibliographies and historical notes will be provided.

Minicourse #6: Writing to learn mathematics is being organized by AGNES AZZOLINO, Middlesex County College. Part A is scheduled from 8:30 a.m. to 10:30 a.m. on

Friday, August 10, Part B from 2:30 p.m. to 4:30 p.m. on Friday, August 10, and Part C from 8:00 a.m. to 10:00 a.m. on Saturday, August 11. Enrollment is limited to 50.

The objectives of this Minicourse are to establish a community interested in writing to learn mathematics (WTLM) and to broaden the awareness of its members. Participants will consider and discuss ways to use WTLM; *talk* to each other, exchange materials, and consider the next steps for their development of WTLM techniques and assignments. [Participants are encouraged to bring copies of written materials they wish to share.] The novice will see a broad but cohesive picture of possible writing assignments and will hear about individuals using WTLM. The intermediate will be given an opportunity to verbalize about successes and problems and to ask advice of experts. The experts will be afforded the opportunity to stimulate novices, intermediates, and other experts by a method other than the publication of a journal article or presentation of a paper.

Minicourse #7: Exploring mathematics with the NeXT computer is being organized by CHARLES G. FLEMING and JUDY D. HALCHIN, Eastern Illinois University. Part A is scheduled from 8:30 a.m. to 10:30 a.m. on Friday, August 10, and Part B from 2:30 p.m. to 4:30 p.m. on Friday, August 10. Enrollment is limited to 30.

The goals of the Minicourse are as follows: (1) To examine software currently available for the NeXT computer that can be used in undergraduate mathematics courses. We will look at software for the NeXT which is currently available for use in courses such as calculus, differential equations, abstract algebra, and differential geometry, as well as *Mathematica* packages and front ends. (2) To examine the software development tools available on the NeXT computer, including Interface Builder. We will also look briefly at ways in which other programs can communicate easily with *Mathematica*. (3) To demonstrate the hardware capabilities of the NeXT computer. In particular, we will demonstrate the sound and high resolution capabilities of the NeXT computer.

Participants will participate in "hands-on" activities with all of the software discussed. While no actual programming will be required, participants should have a basic understanding of programming in a high-level language.

Minicourse #8: A mathematician's introduction to the HP-48SX scientific expandable calculator for first-time users is being organized by JOHN KENNELLY and DON LATORRE, Clemson University. Part A is scheduled from 8:30 a.m. to 10:30 a.m. on Friday, August 10, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, August 11. Enrollment is limited to 30.

The Minicourse will be a mathematician's hands-on introduction to the HP-48SX and some of the new features which make it so powerful — like the Equation

Writer, the HP Solve and Plot applications, and the Matrix Writer. The course will illustrate uses of the 48SX in several undergraduate courses: calculus, linear algebra, and differential equations. Participants will be given a handout that includes several customized programs for use in these courses. The transfer of data from one 48SX to another and between the 48SX and a microcomputer will be demonstrated, and the use of plug-in cards to expand memory — both ROM and RAM — will be discussed. An HP-48SX calculator will be loaned to each participant in the Minicourse.

Minicourse #9: Starting, funding and sustaining mathematics laboratories is being organized by JAMES E. WHITE, Kenyon College. Part A is scheduled from 8:30 a.m. to 10:30 a.m. on Friday, August 10, and Part B from 2:30 p.m. to 4:30 p.m. on Friday, August 10. Enrollment is limited to 30.

This Minicourse will familiarize participants with successful examples of the use of computer laboratories in the undergraduate mathematics curriculum. The course will feature descriptions of ongoing examples of such laboratories by three or four faculty who have been involved in them in a variety of settings. The presentations will describe the curricular innovations that have been made possible by the availability of a mathematics computer laboratory, the software that has been found useful, and the means by which the laboratories obtained their initial funding and continuing support. Part of the Minicourse will outline sources of funding and methods for increasing the probability of success for proposals for such funding. Participants who want a copy of the instructional software may request it at the course and it will be sent to them for a nominal fee.

Minicourse #10: CAS laboratory projects for calculus is being organized by CARL LEINBACH, Gettysburg College. Part A is scheduled from 8:00 a.m. to 10:00 a.m. on Saturday, August 11, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, August 11. Enrollment is limited to 30.

This course is designed to acquaint participants with a method of presenting calculus as a laboratory course. In addition to discussing the philosophy and the logistics of a laboratory calculus course, participants will have hands-on experience working in simulated laboratory sessions. Participants will also work with each other and with the instructor to develop outlines for labs that they can present as part of their own calculus course. Laboratories will be conducted using the DERIVE Computer Algebra System available for MS/DOS machines with at least 512K of internal memory. The labs that will be presented may be easily transferred to a Computer Algebra System having a competent symbolic manipulation package, graphics display, and numerical approximation routines.

Minicourse #11: Producing mathematics courseware with Mathematica: Calculus and Mathematica is being

organized by DON BROWN, HORACIO PORTA, and JERRY UHL, University of Illinois, Urbana. Part A is scheduled from 10:15 a.m. to 12:15 p.m. on Saturday, August 11, and Part B from 3:15 p.m. to 5:15 p.m. on Saturday, August 11. Enrollment is limited to 30.

Mathematica Notebooks allow fully word-processed text to be inserted in the middle of active *Mathematica* code. This constitutes a new medium of communication that combines the advantage of a standard word processor, the advantage of an enormously powerful easy-to-use computer algebra system and superb graphic capabilities. With *Mathematica* Notebooks, the reasons for an upcoming calculation can be discussed, the calculation can be executed and the meaning of the result can be assessed in one single medium. An electronic text, *Calculus & Mathematica*, is under development at Illinois and is running in test form at ten other schools. This Minicourse will consist of a brief introduction to *Mathematica*, the examination of a few *Calculus & Mathematica* Notebooks, and an introduction to writing new *Mathematica* Notebooks for use in the classroom.

Minicourse #12: Exploring statistics and discrete mathematics topics using inexpensive graphing calculators is being organized by FRANKLIN DEMANA and BERT K. WATTS, Ohio State University. This Minicourse is scheduled from 10:15 a.m. to 12:15 p.m. on Saturday, August 11. Enrollment is limited to 40.

Inexpensive (\$75 or less) graphing calculators can dramatically change the way we teach (and students learn) "finite" mathematics, precalculus and calculus. Participants will learn how to use "state-of-the-art" Texas Instruments graphing calculators. Graphing calculators are powerful tools that permit the user to make and test generalizations by looking at a large number of examples in a short period of time, to easily solve large (up to 6 by 6) systems of equations, and to deal with problems and applications that are not contrived. Mathematical topics will include solving systems of equations, matrix algebra, data analysis, and statistical modeling.

Minicourse #13: Spreadsheet based mathematical topics for nonmathematics majors is being organized by V. S. RAMAMURTI, University of North Florida. Part A is scheduled from 10:15 a.m. to 12:15 p.m. on Saturday, August 11, and Part B from 3:15 p.m. to 5:15 p.m. on Saturday, August 11. Enrollment is limited to 30.

Business students form a very large clientele for mathematics courses nowadays. All these students invariably learn to use the electronic spreadsheet which is the basic program for financial analysis. Mathematics departments can take advantage of this and have these students also learn mathematics through the electronic spreadsheet. There are two benefits to this approach: (1) These students do not need to learn a new programming language. Spreadsheets are programs they can readily relate to.

(2) Since many of these students will continue to use spreadsheets in their jobs, the knowledge gained in school does not become useless when they finish school. In this course, use of spreadsheets in learning the following traditional topics for business majors will be demonstrated: Gaussian elimination, matrix operations, solving linear programming problems, graphing, limits and continuity, areas under curves. Necessary computer facilities and the software for gaining hands-on experience will be available. Lecture notes will be provided.

Participants interested in attending any of the MAA Minicourses should complete the MAA Minicourse Pre-registration Form found at the back of this issue and send it directly to the MAA office at the address given on the form so as to arrive prior to the June 6 deadline. **DO NOT SEND THIS FORM TO PROVIDENCE.** Please note that these MAA Minicourses are NOT the AMS Short Course. After the deadline, potential participants are encouraged to call the MAA headquarters at 800-331-1622.

Please note that prepayment is required. Payment can be made by check payable to MAA (Canadian checks must be marked "in U.S. funds") or VISA or MASTERCARD credit cards.

The MAA Minicourses are open only to persons who register for the Joint Mathematics Meetings and pay the Joint Meetings registration fee. **If the only reason for registering for the Joint Meetings is to gain admission to a MAA Minicourse, this should be indicated by checking the appropriate box on the MAA Minicourse Pre-registration Form.** Then, if the Minicourse is fully subscribed, full refund can be made of the Joint Meetings preregistration fee. Otherwise, the Joint Meetings preregistration will be processed, and then be subject to the 50% refund rule. Participants should take care when cancelling Minicourse preregistration to make clear their intention as to their Joint Meetings preregistration, since if no instruction is given, the Joint Meetings registration will also be cancelled. **PREREGISTRATION FORMS FOR THE JOINT MEETINGS SHOULD BE MAILED TO PROVIDENCE PRIOR TO THE DEADLINE OF JUNE 6.**

The registration fee for MAA Minicourses #4, 7, 9, 10, 11, and 13 is \$60. The registration fee for Minicourse #12 is \$18. The registration fee for all other Minicourses is \$36.

Contributed Papers: Contributed papers are being accepted on several topics in collegiate mathematics. The topics, organizers, their affiliations, and the days they will meet are:

- Liberal arts mathematics courses*, SOLOMON A. GARFUNKEL, Consortium for Mathematics and its Applications (COMAP), Friday, August 10, morning and afternoon.

This session will be devoted to the mathematical content and course design for liberal arts students. Papers which address these themes in the context of long-term literacy goals as well as core undergraduate curriculum issues are solicited.

- *Toward equity and excellence: Efforts to increase the number of minorities and women in the profession*, CAROLYN R. MAHONEY, California State University at San Marcos, Thursday afternoon, August 10, and Friday morning, August 10.

Papers are welcome discussing precollege interventions, college and graduate school seminar workshops, and mentor programs, institutional initiatives as well as state and national efforts aimed at increasing participation of underrepresented groups.

- *The interface between mathematics and operations research*, LINN I. SENNOTT, Illinois State University, Normal, Thursday, August 10, morning and afternoon.

The session has two purposes: 1) to illustrate the contributions of mathematics to the development of operations research via such topics as linear programming, queueing theory, etc., and 2) to acquaint mathematicians with the application of operations research models. Papers are solicited in either (or both) of these areas.

Presentations are normally limited to ten minutes, although selected contributors may be given up to twenty minutes. Individuals wishing to submit papers for any of these sessions should send the following information to the MAA Washington office at 1529 Eighteenth Street, NW, Washington, DC 20036 by May 18:

1. Title
2. Intended session
3. A one-paragraph abstract (for distribution at the meeting)
4. A one-page outline of the presentation

Other MAA Sessions

MAA Undergraduate Student Paper Session: The third MAA Undergraduate Student Paper Session will take place from 10:30 a.m. to 12:20 p.m. on Saturday, August 11. The session is sponsored by the MAA in conjunction with Pi Mu Epsilon, the undergraduate mathematics honorary society, and the MAA Student Chapters. Nominations for 10-15 minute papers from Sections of the MAA, mathematics departments, and other interested parties, with a brief abstract, should be sent to Ronald F. Barnes, Department of Mathematics, University of Houston-Downtown, 1 Main St., Houston, TX 77002. Nominations would be appreciated by May 15, 1990.

In addition to the Student Paper Session, MAA and Pi Mu Epsilon will cosponsor a number of other student activities. Funds for these activities and travel

assistance (up to \$200) for authors of papers selected have been provided by a grant from the EXXON Education Foundation. Following the mathematical circus on Wednesday, there will be a student reception from 6:00 p.m. to 7:00 p.m. A breakfast for MAA Chapter Advisors and Coordinators is scheduled for Thursday morning from 7:30 a.m. to 8:30 a.m.

There will be an MAA Student Chapter Panel Discussion from 9:00 a.m. to 10:30 a.m. on Thursday, August 9, organized by APARNA W. HIGGINS, University of Dayton. The purpose of the discussion will be to show how mathematics is used in the "real" world and to indicate a variety of career opportunities available to people with a Bachelor's degree in mathematics. Mathematicians from local Ohio industries will serve on the panel.

There will be a session on *Modeling* from 8:00 a.m. to 9:30 a.m. on Friday, August 10, organized by BEN A. FUSARO, Salisbury State University. Outstanding student teams from the 1990 Mathematics Contest in Modeling will present their attempts to handle two unsolved real-world problems. The first requires the distribution pattern for the diffusion of drugs within the brain. The second asks for an efficient way for two vehicles to plow (or sweep) a grid of roads.

Poster Session on Symbolic Computation: The Committee on the Undergraduate Program in Mathematics (CUPM) Subcommittee on Symbolic Computer Systems is sponsoring a poster session from 8:00 a.m. to noon on Thursday, August 9. The particular focus of this session will be *What students learn in the symbolic computing environment*. This will be an opportunity for those interested in symbolic computation (including use of supercalculators) to exchange information and opinions informally. Each presenter will have a table to display or distribute material, and sufficient electrical outlets will be available to facilitate computer demonstrations. (Presenters must furnish their own computers, however, and sign a release of liability form which should be requested from the organizer, Joan R. Hundhausen, Department of Mathematics, Colorado School of Mines, Golden, CO 80401.)

A broad range of participation is encouraged, with respect to types of institutions, courses, and topics. Since only 25 presenters can be accommodated, it may be necessary to select among potential participants based upon descriptions of the projects. Anyone interested in participating should write to the organizer prior to May 1. Please include a brief description of the project or topics, numbers of faculty and students (or institutions) involved, and, if possible, the impact upon the learning of mathematics.

Panel Discussion on Symbolic Computation: The CUPM Subcommittee on Symbolic Computer Systems is sponsoring a panel discussion on *The pedagogical impact of computer algebra systems on college mathematics*.

curricula. This panel is scheduled from 2:30 p.m. to 4:00 p.m. on Thursday, August 9. The panelists are WILLIAM BOYCE, Rensselaer Polytechnic Institute; JOHN HARVEY, University of Wisconsin, Madison; MICHAEL HENLE, Oberlin College; and JEANETTE PALMITER, Kenyon College. The panel organizer is ROBERT J. LOPEZ, Rose-Hulman Institute of Technology. The panelists, charged to be specific, will consider the curricula of the first two years of college mathematics, the advanced mathematics courses, and courses in disciplines such as engineering and physics, addressing the question "Given the availability of computer algebra, what mathematics should (and can) we teach, and how should we teach it?"

Special Presentation on Symbolic Computation: The CUPM Subcommittee on Symbolic Computer Systems is sponsoring a special presentation by PAUL ZORN, St. Olaf College. He will give a lecture at 4:30 p.m. on Thursday, August 9, titled *Symbolic computing in undergraduate mathematics: symbols, pictures, numbers, and insights*.

Panel Discussion on Visualization: The Committee on Computers in Mathematics Education (CCIME) is sponsoring a panel discussion on the *Visualization Project* which will address the role of visualization in teaching and learning mathematics at the undergraduate level. Topics will include the role of computer graphics as well as non-computer based visualization and aspects of visual thinking in a variety of mathematical fields. This panel is an outgrowth of the Project on Visualization, a project of CCIME. The panel discussion is scheduled from 9:00 a.m. to 10:50 a.m. on Friday, August 10, with the discussion expected to last 90 minutes leaving 20 minutes available for questions and discussion. The panel will include WALTER ZIMMERMANN, University of the Pacific (moderator), HERMAN E. GOLLWITZER, Drexel University, and VALERIE A. MILLER, Georgia State University.

Panel on Research in Learning Undergraduate Mathematics: The Committee on the Teaching of Undergraduate Mathematics (CTUM) is sponsoring a panel discussion on research in learning undergraduate mathematics from 9:00 a.m. to 10:50 a.m. on Friday, August 10. The moderator will be LIDA K. BARRETT, Mississippi State University. The panelists will include JOAN FERRINI-MUNDY, University of New Hampshire and Program Director at NSF, and JAMES J. KAPUT, Southern Massachusetts University. The topics discussed will be: survey of current research, relationship between research in learning and the use of technology, math anxiety and minorities, and research in undergraduate participation in mathematics. The organizing committee consisted of ED DUBINSKY (chair), JOHN A. DOSSEY, and BONNIE GOLD.

Open Discussion on Consultants: There will be an open discussion from 3:50 p.m. to 4:50 p.m. on Friday, August 10, on what MAA consultants do during a campus

site visit. It will be led by ALAN C. TUCKER, SUNY at Stony Brook, JOHN W. KENNELLY, Clemson University, and RICHARD MILLMAN, Wright State University, chair of the Committee on Consultants. The discussion is primarily intended for those who are consultants, but anyone who wishes to attend is welcome. In particular, mathematicians who are thinking about having a team of consultants visit their university may want to attend this session.

Panel Discussion on Quantitative Literacy: There will be a panel discussion on *Quantitative literacy* from 8:50 a.m. to 9:40 a.m. on Thursday, August 9, sponsored by the CUPM Subcommittee on Quantitative Literacy Requirements (Linda R. Sons, chair). One of the panelists will be JOANNE S. GROWNEY, Bloomsburg University of Pennsylvania.

Calculus Reform Today: An Overview: The CUPM Subcommittee on Calculus Reform and the First Two Years (CRAFTY) is sponsoring a panel discussion on calculus reform from 9:00 a.m. to 10:20 a.m. on Saturday, August 11. The panelists are members of CRAFTY (Thomas W. Tucker, chair). With support from the National Science Foundation, CRAFTY is preparing a book surveying new calculus projects. The book, which should appear in the *MAA Notes* series in time for the Columbus meeting, includes detailed descriptions of ten projects and abstracts for fifty others. Based on their experiences in the CRAFTY project, the panelists will attempt to give an overview of calculus reform: where it is today and where it seems to be going.

State Mathematics Coalitions: The MAA Science Policy Committee is sponsoring a panel discussion on State Mathematics Coalitions, which are alliances of education, corporate, and public policy leaders working to improve mathematics education. The Mathematical Sciences Education Board, through grants from the Exxon Education Foundation and the Carnegie Corporation of New York, is supporting the development of pilot coalitions in 25 states. This panel discussion, which is scheduled from 10:30 a.m. to noon on Saturday, August 11, will outline the goals and the structure of these coalitions and will describe particular examples of such coalitions and their activities. Panelists include MARJORIE ENNEKING, Portland State University; ROBERT J. KANSKY, Mathematical Sciences Education Board; and HARVEY B. KEYNES, University of Minnesota, Minneapolis (moderator).

Committee on Participation of Women: The Committee on the Participation of Women is sponsoring a special lecture by JUDY GREEN, Marymount University, titled *History of women in the MAA*. This lecture is scheduled at 3:35 p.m. on Saturday, August 11.

The MAA Committee on Participation of Women plans to hold discussion groups following skits about mini-inequities at the San Francisco meeting in January, 1991. It now seeks volunteer discussion leaders able to

spend two hours at the Columbus meeting learning how to become an effective discussion leader. Please inform Pat Kenschaft, Montclair State College, Upper Montclair NJ 07043, Committee Chair.

Prize Session and Business Meeting: The MAA Prize Session and Business Meeting is scheduled from 5:05 p.m. to 6:00 p.m. on Friday, August 10. The Allendoerfer, Ford and Pólya Awards will be presented at this meeting, which is open to all members of the Association.

Board of Governors: The MAA Board of Governors will meet at 8:30 a.m. on Tuesday, August 7. This meeting is open to all members of the Association.

Section Officers: There will be a Section Officers' meeting at 4:00 p.m. on Tuesday, August 7.

Activities of Other Organizations

The Association for Women in Mathematics (AWM) is sponsoring a panel discussion on Thursday, August 9, at 9:00 a.m.

The First Annual Alice T. Schafer Mathematics Prize will be presented at the AWM Membership Meeting which will be held at 10:15 a.m. on Thursday, August 9.

An open reception is planned for Thursday evening, August 9, at 9:00 p.m.

The Joint Policy Board for Mathematics (JPBM) Committee for Mathematics Department Heads has organized a National Meeting of Department Heads at 8:15 p.m. on Tuesday, August 7.

The National Science Foundation (NSF) invites participants at the Joint Mathematics Meetings to meet informally with staff members over the lunch hour (noon to 1:00 p.m.) daily, Thursday–Saturday, August 9–11. Short presentations on proposal writing and processing and Foundation priorities will be followed by the opportunity for individual questions. Please bring a lunch (or not) and join us. The Thursday session will focus on education, the Friday session will focus on research, and the Saturday session will include discussions of education and research. Friday will also provide an opportunity to discuss priorities and processes at other Federal agencies funding mathematics research.

The NSF will also be represented at a booth in the exhibit area. NSF staff members will be available to provide counsel and information on NSF programs of interest to mathematicians. The booth will be open the same days and hours as the exhibits. Times that staff will be available will be posted at the booth.

The Pi Mu Epsilon ($\pi\mu\epsilon$) J. Sutherland Frame Lecture will be delivered on Thursday, August 9, at 8:30 p.m. by RONALD L. GRAHAM, AT&T Bell Laboratories.

There will be sessions for contributed papers Thursday afternoon and Friday morning and afternoon.

The $\pi\mu\epsilon$ Dutch Treat Breakfast will take place on Friday, August 10, at 8:00 a.m. The $\pi\mu\epsilon$ Council will meet from 12:15 p.m. to 1:15 p.m. on Friday, August 10. $\pi\mu\epsilon$ will cosponsor undergraduate student paper sessions with MAA. Further information can be found in the MAA section of this announcement.

Information on the $\pi\mu\epsilon$ banquet can be found in the Social Events section of this announcement.

Other Events of Interest

Book Sales and Exhibits

AMS Information Booth: All meeting participants are invited to visit the AMS Information Booth in the exhibit area during the meetings. Complimentary coffee and tea will be served. Carol-Ann Blackwood, Membership Manager of the Society, will be at the booth to answer questions about membership in the Society.

Book Sales: Books published by the AMS and MAA will be sold at discounted prices somewhat below the cost for the same books purchased by mail. These discounts will be available only to registered participants wearing the official meetings badge. Visa and MasterCard credit cards will be accepted for book sale purchases at the meetings. The book sales will be open the same days and hours as the exhibits.

Exhibits: The book and educational media exhibits are open Wednesday through Saturday, August 8–11. The hours they are open are 1:00 p.m. to 5:00 p.m. on Wednesday, 9:00 a.m. to 5:00 p.m. Thursday and Friday, and 9:00 a.m. to noon on Saturday. All participants are encouraged to visit the exhibits during the meetings.

Other Conferences of Interest

Participants interested in the *Workshop for college faculty on using graphing calculators and computer graphing to enhance the teaching and learning of precalculus mathematics and calculus* which will take place right after the Columbus meetings should refer to the news item in the **News and Announcements** section in this issue of *Notices*.

Sculpture Exhibit

During the week of the meetings, the work of Helmut Ferguson will be on display in the Gallery of Hopkins Hall, 128 North Oval Mall. There will be a reception with the artist on Thursday, August 9, from 5:00 p.m. to 7:00 p.m. in the Gallery.

Social Events

MAA Banquet: The culmination of the events on MAA Day will be a banquet open to all participants. ENZO POIANI, Past President of Pi Mu Epsilon, will preside and DAVID P. ROSELLE, President of the University of

Delaware and formerly Secretary of the MAA, will be the featured speaker. MAA members attending will be recognized by Section, in keeping with the emphasis in the Opening Ceremonies on the sectional structure of the MAA. There will be a lively, anecdotal commentary on some high points in the life of the Association. Members are encouraged to come to represent their sections and to celebrate this milestone in the MAA's history. Special 75th Anniversary souvenir tiles will be given to those attending.

It is strongly recommended that tickets for this banquet be purchased through preregistration, since only a very limited number of tickets will be available for sale on-site. Tickets are \$25 each; the price includes gratuity. The menu includes chicken coq au vin, whipped potato, vegetable, rolls, butter, beverage and strawberries Romanoff. Special meals are available upon request, including vegetarian. Interested participants should complete the appropriate section of the Preregistration/Housing Form and include payment. In the event of cancellations, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence by July 31. After that date, no refund can be given.

Reception for MAA 25-Year Members: Since there will be a banquet open to all participants on MAA Day (Wednesday, August 8), there will be no MAA Banquet for 25-year Members at this meeting. However, there will be a special reception for 25-year members of the MAA from 6:00 p.m. to 7:30 p.m. on Tuesday, August 7. This reception is open to those individuals who have been members of the Association for twenty-five years or more, and will be held in the Atrium at the Ramada University Hotel and Conference Center. The Officers of the Association and the members of the Board of Governors will also attend this reception. Champagne punch, nonalcoholic punch, and assorted cheeses will be provided. No formal program is planned, but President Lida K. Barrett will make some welcoming remarks.

It is strongly recommended that tickets for this reception be purchased through preregistration, since only a very limited number of tickets will be available for sale on-site. Tickets are \$5 each; the price includes gratuity. Interested participants should complete the appropriate section of the Preregistration/Housing Form and include payment. In the event of cancellations, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence by July 31. After that date, no refund can be given.

MAA 25-year members are asked to check the box on their Preregistration/Housing Form so special mention of their status can be made on their meetings badge.

Pi Mu Epsilon Banquet: This banquet will take place on Thursday, August 9, at 6:30 p.m., in the River Den Room of the Drake Union. This building is served by the free campus shuttle bus.

It is strongly recommended that tickets for this banquet be purchased through preregistration, since only a very limited number of tickets will be available for sale on-site. Tickets are \$10 each for students and \$14 for all others; the price includes gratuity. The menu includes boneless breast of chicken with herb mushroom sauce, wild rice and pistachios, vegetable, rolls and butter, beverage, and sherbert. Special meals are available upon request, including vegetarian. Interested participants should complete the appropriate section of the Preregistration/Housing Form and include payment. In the event of cancellations, a 50% refund of the amount paid for the ticket will be made if notification is received in Providence by July 31. After that date, no refund can be given.

MAA Student Chapters/ $\pi\mu\epsilon$ Reception: All students are invited to attend a reception cohosted by the MAA Student Chapters and Pi Mu Epsilon on Wednesday, August 8, at 6:00 p.m. Refreshments will be served. Certificates for charter chapters will be awarded.

Sock Hop: Let's go to the hop!! Participants are invited to don their saddle shoes, poodle skirts, varsity sweaters, and the like and dance (or listen) to the music of the 50's and 60's at the Sock Hop on Friday evening, August 10, at 6:30 p.m. Entertainment will be provided by a local group called "Frick & Frack" whose amusing skits will bring back memories of "Happy Days". Their music will move everyone to cha-cha, twist, stroll, jitterbug, and do the limbo, while sipping vanilla and cherry colas.

The hop will take place at the Ramada University Hotel and Conference Center, located approximately one mile from the campus on Olentangy River Road. A free shuttle bus will be provided to and from this event. The menu includes grilled hot dogs and hamburgers, cole slaw, potato salad, brownies, cookies (including Oreos), coffee, tea, and punch. For vegetarians, the menu includes vegetarian lasagne, Italian vegetables, tossed salad, rolls with butter, brownies, cookies, coffee, tea, and punch. Participants may indicate their meal preference on the Preregistration/Housing Form. Cherry and vanilla colas may be purchased at the bar, as well as the usual selection of alcoholic beverages.

It is strongly recommended that tickets for this event be purchased through preregistration, since only a very limited number of tickets will be available for sale on-site. Tickets are \$15 for adults and \$6 for children 12 years of age and under, and may be purchased through preregistration by completing the appropriate section of the Preregistration/Housing Form, and enclosing the payment. A 50% refund can be made on Sock Hop tickets until July 31. After July 31, no refunds are possible.

Summer List of Applicants

At the direction of the AMS-MAA-SIAM Committee on Employment Opportunities, which is charged with

operation of the Employment Register and with the publication of *Employment Information in the Mathematical Sciences*, the Society will publish a Summer List of mathematical scientists seeking employment for distribution at the Columbus meetings.

Copies of the 1990 Summer List of Applicants will be available at the Transparencies section of the registration desk for \$6. Following the meetings, they may be purchased from the AMS office in Providence for \$8. This list should prove useful to employers who have last-minute openings in the latter part of the summer or in the fall.

The deadline for receipt of applicant forms to appear in this Summer List is June 6.

The applicant preregistration résumé and instructions on its completion can be found in this issue of *Notices*.

Instead of an Employment Register at the Summer Meetings in Columbus, there will be an opportunity for posting of both applicant résumé forms and employers' announcements of open positions in or near the main meetings registration area. There will be no special room set aside for interviews. No provisions will be made by the Society for interviews; arrangements will be the responsibility of each employer and applicant. Messages may be left in the message box located in the registration area.

Special applicant and employer forms will be available at the Transparencies section of the registration desk both for applicants to post résumés and for employers to post forms announcing positions.

Applicants who submit an applicant form, but do not plan to attend the meetings, will appear on the printed list only. There is no provision made for posting résumés for participants who do not attend the meetings. No printed lists of employers or applicants who register at the meetings will be available after the meetings.

How to Preregister and Get a Room

How to Preregister

The importance of preregistration cannot be overemphasized. Those who preregister pay fees considerably lower than the fees that will be charged for registration at the meetings, and receive typeset badges instead of typewritten ones.

There are two separate preregistration deadlines, each with its own advantages and benefits.

All ORDINARY preregistrants will receive formal acknowledgements prior to the meetings. FINAL preregistrants will receive a letter from the Mathematics Meetings Housing Bureau (including receipt of payment) prior to the meetings.

ORDINARY Preregistration
(and Residence Hall Housing)
FINAL Preregistration
(no Housing)

June 6

July 11

Please note that requests for residence hall housing through the Mathematics Meetings Housing Bureau and applicant forms for the Summer List of Applicants must be received by the ORDINARY deadline of June 6.

ORDINARY Preregistration: Those who preregister by the ORDINARY deadline of June 6 will receive their badge and program in the mail two to three weeks prior to the meetings, unless they check the appropriate box to the contrary on the Preregistration/Housing Form.

So, it is extremely important that the mailing address given on the Preregistration/Housing Form be one at which the participant can receive this mailing. There will be a special assistance desk at the meetings to assist individuals who either do not receive this mailing or who have a problem with their badge. Please note that a \$2 replacement fee will be charged for programs and badges that are mailed but not taken to the meetings. Unfortunately, it will not be possible to make changes to badges received through the mail before the meetings. Also, it will not be possible to include any tickets to special events purchased through preregistration in the mailing with the badge and program. There will be a special Tickets section at the Joint Mathematics Meetings Registration Desk where prepurchased tickets to the MAA Banquet, $\pi\mu\epsilon$ Banquet, MAA Reception for 25-year Members, MAA Student Chapter Advisors and Coordinators Breakfast, and/or the Sock Hop may be picked up.

FINAL Preregistration: Those who preregister by the FINAL deadline of July 11 will pick up their badge and program at the meetings. Unfortunately, it is not possible to provide FINAL preregistrants with housing or tickets to special events, although the latter may still be available for purchase at the meetings. Please note that the July 11 deadline is firm and any forms received after that date must be returned and full refunds issued.

It is essential that the Preregistration/Housing Form (found at the back of this issue) be completed fully and clearly. In the case of several preregistrations from the same family, each family member who is preregistering should complete a separate copy of the Preregistration/Housing Form, but all preregistrations from one family may be covered by one payment. Please print and type the information requested, and be sure to complete all sections. Absence of information (missing credit card numbers, incomplete addresses, etc.) causes a delay in the processing of preregistration for that person.

Please provide your nickname if you wish this information to be printed on your badge. Also, it is planned to make available at the meetings a list of preregistrants

by area of interest. If you wish to be included in this list, please provide the *Mathematical Reviews* classification number of your major area of interest on the Preregistration/Housing Form. (A list of these numbers appears on the back of the AMS abstract form.) The master copy of this list will be available for review by participants at the Message Center section of the registration desk.

ELECTRONIC Preregistration: Preregistration through electronic mail is also available. Anyone wishing to preregister through this method should send a message to MEET@MATH.AMS.COM requesting this service. A message will be sent back within 24 hours with instructions on how to complete the format required. **Credit card is the ONLY method of payment which can be accepted for electronic preregistration.** Forms received through this method will be treated in the same manner as forms received through U.S. mail. Receipt of the Preregistration/Housing Form and payment will be acknowledged by the Mathematics Meetings Housing Bureau. Participants are advised to bring a copy of this acknowledgement with them to Columbus. The same deadlines apply as for normal preregistration. **Please note that forms for the Summer List of Applicants cannot be sent through electronic mail.** Only the form found elsewhere in this announcement can be accepted.

Registration Fees: The Joint Meetings registration fees at the meetings will be 30% higher than the preregistration fees listed below.

Joint Mathematics Meetings

Member of AMS, Canadian Mathematical Society, MAA, ΠME	\$ 73
Emeritus Member of AMS, MAA	\$ 26
Nonmember	\$110
Student/Unemployed	\$ 26

AMS Short Course

Student/Unemployed	\$ 15
All Other Participants	\$ 40
Emeritus Member of AMS, MAA	\$ 15

MAA Minicourses

(if openings available)	
Minicourses # 1, 2, 3, 5, 6, 8	\$ 36
Minicourses #4, 7, 9, 10, 11, 13	\$ 60
Minicourse #12	\$ 18

Modes of payment which are acceptable, provided they are payable in U.S. dollars to the order of the American Mathematical Society, are U.S. Postal Money Orders, certified U.S. bank checks, U.S. bank money orders, personal checks drawn on a U.S. bank, or credit card (Visa or MasterCard only). A \$5 charge will be imposed for all invoices prepared when preregistration forms are submitted without accompanying check(s) for the preregistration fee.

are accompanied by an amount insufficient to cover the total payments due. We are sorry, but it is not possible for the Mathematics Meetings Housing Bureau to refund amounts less than \$2. Preregistration forms received well before the deadline of June 6 which are not accompanied by correct payment will be returned to the participant with a request for resubmission with full payment. This will, of course, delay the processing of any housing request.

An income tax deduction is allowed for education expenses, including registration fees, cost of travel, meals and lodging incurred to (i) maintain or improve skills in one's employment or trade or business or (ii) meet express requirements of an employer or a law imposed as a condition to retention of employment, job status, or rate of compensation. This is true even for education that leads to a degree. However, the Tax Reform Act of 1986 has introduced significant changes to this area. In general, the deduction for meals is limited to 80% of the cost. Unreimbursed employee educational expenses are subject to a 2% of adjusted gross income floor. However, there are exceptions to these rules. Therefore, one should contact one's tax advisor to determine the applicability of these provisions.

There is no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

Nonmembers who preregister or register at the meetings and pay the nonmember fee will receive mailings from AMS and MAA, after the meetings are over, containing information about a special membership offer.

How to Get a Room

The use of the services offered by the Mathematics Meetings Housing Bureau requires preregistration for the Joint Mathematics Meetings. All reservation requests for university accommodations must be received in writing and be processed through the Housing Bureau. Telephone requests cannot be accepted. **Please do not contact the university directly, since they will only refer callers back to the Housing Bureau.**

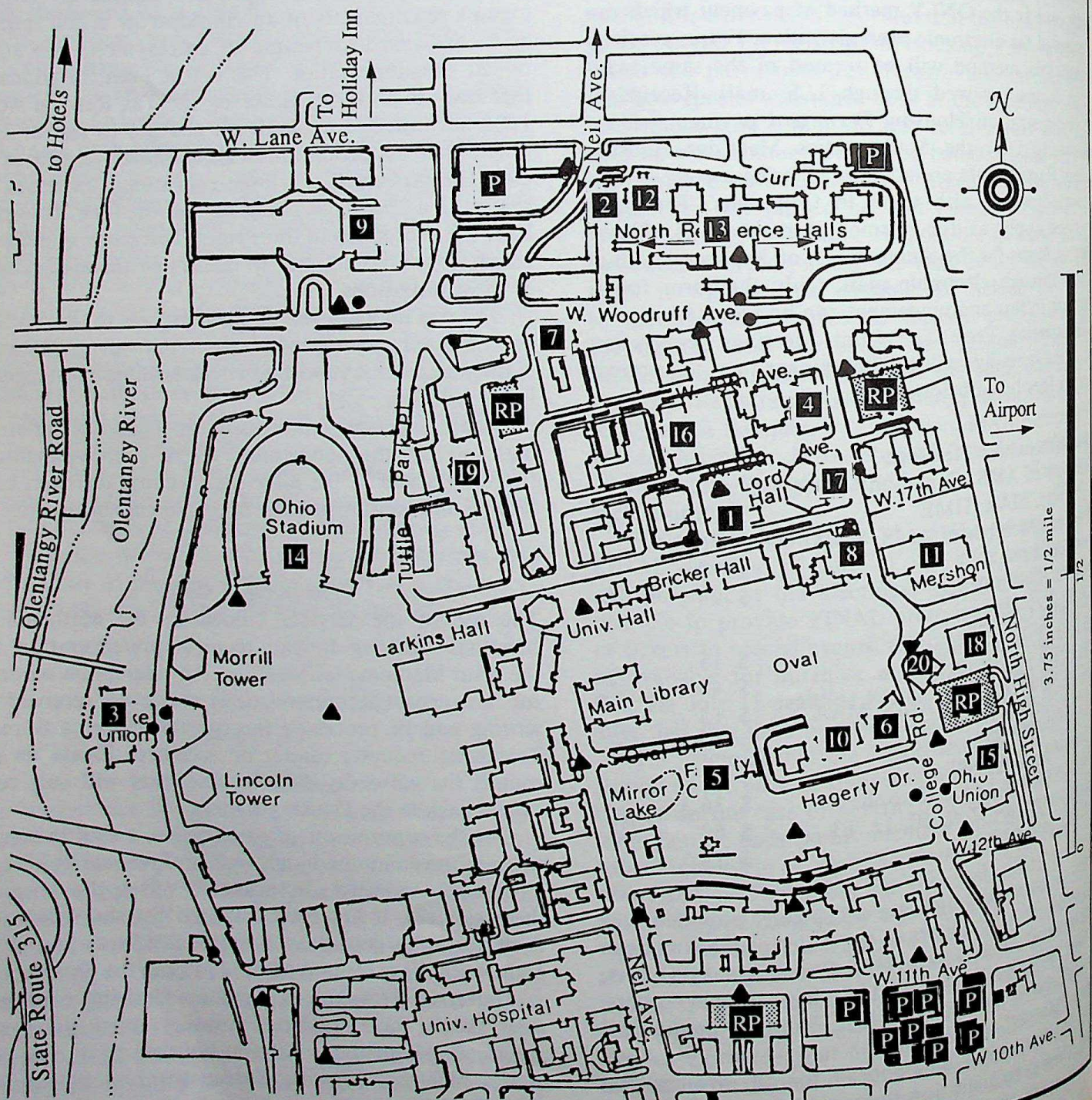
For the convenience of participants, a shuttle service to and from outlying hotels and professional child care have been arranged. In order to offset the costs of these services, it has been arranged for the hotels and dormitories to collect an additional \$3 per room per night, with the exception of child rates in the dormitories.

University Housing: Participants desiring confirmed reservations for on-campus housing must preregister and send payment in full for housing to the Mathematics Meetings Housing Bureau **prior to the June 6, 1990 deadline.** Participants in the Joint Mathematics Meetings may occupy residence hall rooms at The Ohio

The Ohio State University

- | | |
|--------------------------|---------------------------------|
| 1-Denney Hall | 11-Mershon Auditorium |
| 2-Drackett Tower | 12-North Commons |
| 3-Drake Union | 13-North Residence Halls |
| 4-Evans Laboratory | 14-Ohio Stadium |
| 5-Faculty Club | 15-Ohio Union |
| 6-Hagerty Hall | 16-Smith Laboratory |
| 7-Hitchcock Hall | 17-Stillman Hall |
| 8-Hughes Hall | 18-Sullivant Hall |
| 9-Ice Rink | 19-Central Classroom |
| 10-Mendenhall Laboratory | 20-Page Hall (MAA's Birthplace) |

- Free Campus Loop Bus Stops
- ▲ Emergency Telephone Locations
- P Public Parking
- RP Garage Parking (Ramp)



State University during the period August 5 to August 12 only. **All must check out by 10:00 a.m. on August 12.** All rooms on campus are offered through a room/board package ONLY. A very limited number of rooms on campus will be available for those participants who do not preregister but plan on attending the meetings and registering on-site.

All check-ins and room assignments will be done at the University Residential Office (URO), located in Drackett Tower, ground floor lobby. The URO will not accept any payments for housing assigned through preregistration. ALL advance payments for housing must be sent to the Housing Bureau in Providence. (See Preregistration/Housing Form.) ALL balances due on preregistration and/or housing must be paid at the Meetings Registration Desk during the hours registration is open. These payments may be made with cash, personal checks, travelers' checks, VISA, or MasterCard. No other credit cards can be accepted. The Meetings Registration Desk cannot accept payments for university housing that was not obtained through preregistration (walk-in room assignments). Payments for rooms assigned after preregistration are due at check-in time and must be made at the URO. Payments at the URO may be made with cash, traveler's checks, personal checks, VISA or MasterCard. No other credit cards can be accepted.

Participants requesting housing on The Ohio State University campus will be assigned to a room in one of the North Residence Halls (see map). The Housing Bureau will forward all requests for housing to the URO, who will assign all rooms. **The Housing Bureau, therefore, is not responsible for room assignments in the residence halls.**

Families with children will be permitted to stay in the dormitories. With the exception of two special family packages, all children over five years of age will be charged the full adult room and board rate. The two family packages are: 1) a 27% discount on the room and board package for two adults and one child 6-16 years old staying in the same room, and 2) a 42% discount on the room and board package for two adults and two children 6-16 years old staying in the same room. However, children in a room with just one adult will each be charged the per person adult double room and board rate. There is no room charge for children under six years old; however, they will each be charged the full meal rate. There are no cribs or rollaways available. The maximum number of occupants allowed in one room is four. (See section on **Hotel Accommodations** below for alternate housing for families.)

The North Residence Halls consist of both high rise and low rise buildings. All buildings are air conditioned. The low rise buildings have four floors and service elevators that can be used. The high rise buildings have 12 floors and are equipped with passenger elevators.

These buildings are equipped with ramps; however, there is a limited number of rooms accessible to the handicapped. The halls and rooms are generally too narrow for a wheelchair to be maneuvered comfortably. All rooms contain two bunk beds, four chest of drawers (including four lockable drawers), and two closets. They connect to a bathroom as well as a lounge that contains a telephone, four desks with desk lamps, and four chairs. There are very few clothes hangers in the rooms. Participants are advised to bring their own alarm clock and clothes hangers. At check-in, participants will find two towels and a washcloth in their rooms. They will also be given a key that unlocks their room and the outside door of the building. Rooms will be prepared for occupancy in advance and housekeeping service will be provided Monday through Friday. There is a daily linen change, including towels.

Each North Residence Hall has vending machines for soft drinks, candy, and cigarettes located in the basement or lobby. They also have laundry facilities equipped with coin-operated washers and dryers, soap vending machines, and ironing boards. Firearms, fireworks, pets, or open containers of alcohol are not permitted in or around the residence halls; however alcoholic beverages are permitted inside sleeping rooms. There are smoking and nonsmoking lounges; however, smoking is permitted inside sleeping rooms. There are no nonsmoking rooms. Each hall is equipped with an Early Fire Detection and Warning System. All rooms have smoke detectors that are connected to a panel in the URO.

Check-In Locations and Times: All check-ins and room assignments will be done in the URO, located in the ground floor lobby of Drackett Tower. The office is open 24 hours a day, seven days a week.

Driving directions from the Port Columbus Airport to the URO are as follows: Take a left on Steltzer Road. Take ramp onto Route 62. Get off on 5th Avenue West. Take a right on N. 4th Avenue. Take a left on Lane Avenue. Drackett Tower is at the corner of Lane Avenue and Neil Avenue. Directions to specific residence halls will be provided by the URO. There will be students available at the URO to assist with luggage. Participants can park temporarily in the lots labeled "P" (see map) while checking in; however, parking permits for longer term parking must be purchased at a cost of \$1.30 per day at the URO.

At the time of check-in, participants assigned rooms through the Mathematics Meetings Housing Bureau will be checked against a master list (Housing Bureau acknowledgement may prove useful) and asked to sign a statement to be used solely for the purpose of verifying the university's billing to the Housing Bureau. Each person will also receive one room key, a meal card, and a guest brochure. Those participants being assigned a room on-site by the URO will be required to fill out

a housing form and make payment in order to receive a room key. Spouses desiring a room key must follow this procedure also. **Please note that, although there is no deposit required for keys, a penalty of \$92 will be imposed for each key lost or not returned.** It is the responsibility of the Housing Bureau to collect this penalty; therefore, it is requested that proper caution be exercised to avoid this charge. At checkout, all keys must be returned to the URO. Should the clerk not be present, please ensure that your name is left at the desk with the key.

Room and Board Rates: The rates found in the chart which follows apply for residence hall accommodations at the Ohio State University.

Please note that a minimum room-and-board package would be one night's lodging, one dinner and one breakfast. The Mathematics Meetings Housing Bureau will accept changes to packages reserved up until July

16. After that, all changes will have to be made directly with the URO. The URO will accept changes in packages reserved up until 48 hours prior to check-in. Any requests for exceptions to this policy should be addressed to Douglas Koyle, Manager of Conference/Orientation Housing, Royer Student Center, 85 Curl Drive, Columbus, OH 43210, 614-292-9725. All daily room-and-board packages include dinner on the night of arrival and breakfast the next day. The last meal of a package will be breakfast on the day of check-out. There can be no exceptions to meal plans offered, nor can any refunds be issued for meals missed. Meal cards are nonrefundable.

Food Services: Residence hall guests will dine in the North Commons. It is equipped with ramps for the handicapped. Serving hours for breakfast are 6:30 a.m. to 9:00 a.m., Monday-Friday, and 7:00 a.m. to 9:00 p.m., Saturday-Sunday. Serving hours for dinner are

The Ohio State University Room and Board Rates

	Adults* (per person)	Children* (per person)	2 Adults & 1 Child 6-16 (whole package)	2 Adults & 2 Children 6-16 (whole package)	Children under 6 years **
8/5	\$35 single \$21 double	\$33 single \$19 double	\$65	\$77	\$9
8/6	\$35 single \$21 double	\$33 single \$19 double	\$65	\$77	\$9
8/7	\$35 single \$21 double	\$33 single \$19 double	\$65	\$77	\$9
8/8	\$35 single \$21 double	\$33 single \$19 double	\$65	\$77	\$9
8/9	\$35 single \$21 double	\$33 single \$19 double	\$65	\$77	\$9
8/10	\$35 single \$21 double	\$33 single \$19 double	\$65	\$77	\$9
8/11	\$35 single \$21 double	\$33 single \$19 double	\$65	\$77	\$9

* There can be a maximum of four adults or children per room. They will EACH be charged the double rate per night.

** There is no room charge for children under six years of age; however, there is a full meal charge (per day) for each such child.

4:30 p.m. to 6:15 p.m., Monday-Sunday. Meal cards must be presented at each meal for admission to the dining area. They are not refundable and there is a replacement charge for lost meal cards. Children 16 years of age and under must be accompanied by parents in the dining area. A typical breakfast is eggs, bacon, hot cereal, cold cereal, toast, griddle cakes with syrup, assorted fresh fruit, juices, etc. A typical dinner offers one or two entrees, vegetables, rolls, salad bar, desserts, fresh fruit, and beverages. Entrees, soups, vegetables, breads and desserts are served from a cafeteria line; a self-service salad bar and beverage stations are in the dining area. Servings are generous; unlimited seconds are allowed. It is regretted that there are no Kosher meals available.

A very limited number of meals is available in the dining rooms on a cash basis for guests not staying in the residence halls. The approximate cash price for breakfast is \$2.50 and for dinner \$6.

There are several eating establishments located in the Ohio Union. They range from Chinese food to pizza and are generally open from 10:30 a.m. to 9:30 p.m. The cafeteria, located on the second floor, is open from 7:00 a.m. to 10:00 p.m., Monday-Wednesday, to midnight Thursday-Friday, and 2:00 p.m. to 10:00 p.m. on Sunday. There is also a sit-down dining area called the Terrace Dining Room located on the third floor. Lunch is served there from 11:30 a.m. to 1:30 p.m.; it is closed on weekends.

There are also many fast food restaurants in the immediate vicinity of the university, the majority of them located on N. High Street.

Hotel/Motel Accommodations: Please see the following page for instructions on how to obtain hotel and motel accommodations. A free shuttle between the hotels and the Ohio Union on the campus will be provided according to the following schedule:

Tuesday, August 7	7:00 a.m. to 11:00 p.m.
Wednesday, August 8	7:00 a.m. to 10:00 a.m. and 4:00 p.m. to 11:00 p.m.
Thursday, August 9	7:00 a.m. to 10:00 a.m. and 4:30 p.m. to 11:30 p.m.
Friday, August 10	7:00 a.m. to 10:00 a.m. and 4:00 p.m. to 11:00 p.m.
Saturday, August 11	7:00 a.m. to 10:00 a.m. and 4:00 p.m. to 6:00 p.m.

From 5:30 p.m. to 9:30 p.m. on Friday, August 10, an additional free shuttle will run this route to accommodate participants attending the Sock Hop.

Participants should be aware that when major conventions occur in any city, additional safety problems are created, especially at night. Those who are attending the meetings alone, or who are concerned about walking to and from the meetings after dark, are encouraged to choose a

hotel in close proximity to the campus. Participants are also urged to read the "Words to the Wise" in the local information insert in the program.

Miscellaneous Information

Audio-Visual Equipment: Standard equipment in all session rooms is one overhead projector and screen. (Invited 50-minute speakers are automatically provided with two overhead projectors.) **Blackboards are available only in some rooms.**

AMS speakers requiring additional equipment should contact the Audio-Visual Coordinator for the meetings, at the AMS office in Providence at 401-455-4140, or electronic mail WSD@MATH.AMS.COM by June 1.

MAA speakers requiring additional equipment may make written request for one additional overhead projector/screen, 35mm carousel slide projector, 16mm sound film projector, or VHS video cassette recorder with one color monitor. Such requests should be addressed to the Audio-Visual Coordinator for the meetings who will forward them to the MAA Associate Secretary for Meetings for possible approval. These requests should also be received by June 1.

Camping and RV Facilities: Alton Campground, 6552 W. Broad Street, Columbus, OH, 614-878-9127, is the closest campground. It is situated 11 miles west of The Ohio State University Campus (three miles west of the 270 Outerbelt on US #40 - West side of Columbus). It has full hook-ups and shower house; approximate cost is \$12 per night.

Alum Creek State Park, 3615 S. Old State Road, Delaware, OH 614-548-4631 or 548-4039 (Campground), is located approximately 10-15 miles northeast of the campus. Located approximately one mile west of I-71 on State Rt. 36 & 37. Cost is \$10 per night with electric hook-up; reservations not accepted. Amenities: shelter, drinking water, sanitary facilities, picnic tables, parking, hiking, guides. It has electricity, showers, flush toilets, fishing, swimming, dump station, and pet camp, and can accommodate 35 foot length RV's. Alum Creek also has Rent-A-Camp facilities where novice campers may enjoy the camping experience without first purchasing the necessary equipment. Participants arrive at the family camp area to find the 10-by-12-foot lodge-style tent already set up with a dining canopy. Two cots, sleeping pads, cooler, propane stove, lantern, broom, dustpan and welcome mat are all provided as well as a fire ring and picnic table. One Rent-A-Camp unit has been modified to accommodate individuals who use a wheelchair.

Delaware State Park, State Park, Rt. 1, Delaware, OH 43015, 614-369-2761, is located on State Rt. 23, 15 miles north of campus. Cost: \$5 no electricity; \$9 with electricity; reservations not accepted. Amenities:

Columbus Hotels/Motels

As an alternative to university housing, the Housing Bureau lists the following hotels/motels with group rates. They are all located within two miles of the university and are listed below in order of distance from campus. Rates are subject to a 5.75 percent sales/occupancy tax and a 10 percent bed tax. Checkout time is noon. Checkin time for the Holiday Inn, Ramada Hotel, and Days Inn, 3:00 p.m.; for the Parke Hotel(s), 4:00 p.m.; and for the Red Roof Inn and Knight's Inn, noon. The Holiday Inn, Parke, and Ramada offer a free shuttle to and from the airport. All hotels offer a very limited number of nonsmoking rooms and are equipped for the handicapped.

Participants should make their own reservations early directly with the hotels/motels, and should identify themselves as participants in the Joint Mathematics Meetings. Please note that the Ramada is the headquarters hotel and so is a VERY LIMITED number of rooms available at this hotel. Participants making reservations should be prepared to remit a one night's deposit to the hotel or motel or give a major credit card number in order to guarantee their room reservation.

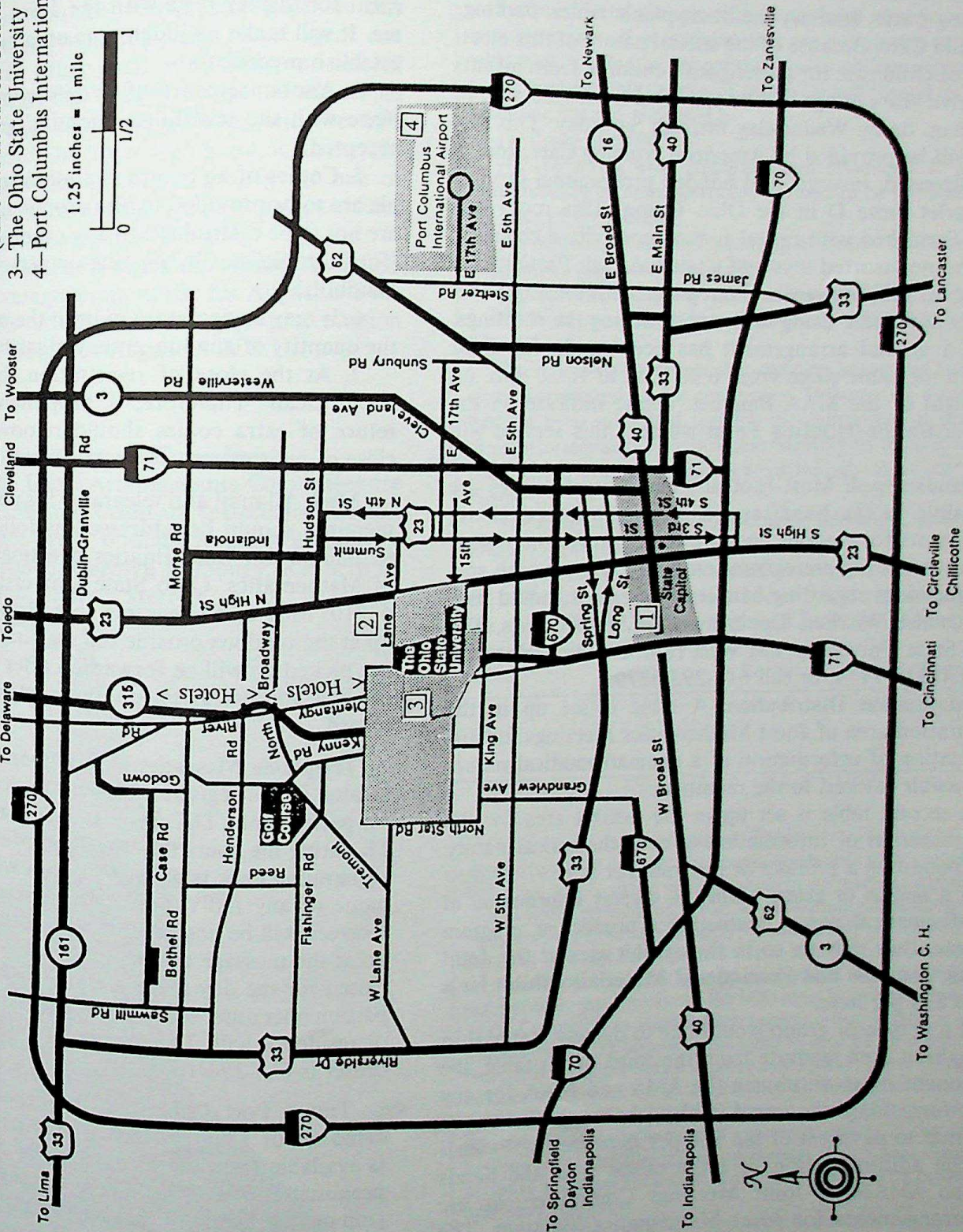
Please make all changes to or cancellations of hotel reservations with the hotels directly. Also please call the hotels directly for information on suites.

	Location	Location to University	Description	Single	Double 1 beds	Double 2 beds	Triple 2 beds	Triple 2 beds w/cot	Quad 2 beds	Quad 2 beds w/cot
Holiday Inn	328 West Lane Ave Columbus, OH 614-294-4848	Across the street	Restaurant Lounge Indoor Pool Free Parking	\$52	\$60	\$60	\$66	\$66	\$72	\$72
Red Roof Inn	441 Ackerman Road Columbus, OH 614-267-9941 1-800-THE-ROOF	.75 miles	Free Parking	31.95	38.95	41.95	43.95	46.95	N/A	N/A
Parke Hotel	3025 Olentangy River Road Columbus, OH 43202 614-267-1111	1 mile	Restaurant Clubhouse Outdoor Pool Free Parking	51	51	51	51	N/A	51	N/A
Parke Suites Hotel (All Suites w/mini kitchens)	behind Parke Hotel	1 mile	Free Parking Access to Parke Hotel Facilities # OF ROOMS VERY LIMITED	59 (Kings ONLY)	59	N/A	N/A	N/A	N/A	N/A
Ramada Hotel (Headquarters)	3110 Olentangy River Rd. Columbus, OH 43202 614-267-7461	1 mile	Restaurant Lounge Outdoor Pool, Fitness Center Free Parking	52 (Kings ONLY)	52	N/A	52 (1 Bed)	57 (1 Bed w/cot)	52 (1 Bed)	57 (1 Bed w/cot)
Knight's Inn	3160 Olentangy River Road Columbus, OH 43202 614-261-0523	1.25 miles	Free Parking	27.95	34.95	36.95	N/A	N/A	N/A	N/A
Days Inn	3232 Olentangy River Road Columbus, OH 43202 614-261-7141 1-800-325-2825	1.25 miles	Restaurant Lounge Outdoor Pool Free Parking	38	38	38	38	N/A	38	N/A

Columbus Area

- 1—Downtown
- 2—Holiday Inn on the Lane
(All other hotels on Olentangy River Road)
- 3—The Ohio State University
- 4—Port Columbus International Airport

1.25 inches = 1 mile



drinking water, sanitary facilities, picnic tables, parking, hiking.

Griggs Dam, 2929 Riverside Drive, Columbus, OH 43221, 614-645-3229, is located on US Rt. 33, northeast of Columbus, five miles from the campus. Cost: \$5 per night. Reservations not accepted. Amenities: shelter, drinking water, sanitary facilities, picnic tables, parking.

Child Care: Because of the special nature of this meeting, free child care for participant's children from infants to twelve years of age will be provided from 7:30 a.m. to 5:00 p.m. daily, Wednesday through Saturday. This service will be provided by American Nursing Care, Inc., a fully licensed, insured, and bonded professional service, in Scarlet Suite D in the Ohio Union. This room will be of furnished with casual furniture, a crib, a changing area, some assorted toys and a television set. Participants should so indicate on the Preregistration/Housing Form if they anticipate using this service during the meetings. Also, a special arrangement has been made for child care in the same room from 6:30 p.m. to 10:30 p.m. on the night of the MAA Banquet. Please indicate on the Preregistration/Housing Form whether this service will be used.

Handicapped: Most (not all) university facilities are accessible to the handicapped. People with special requirements for campus housing should make these clear when submitting preregistration forms. People with special questions regarding handicapped access should contact Denise Witcher, Department of Mathematics, The Ohio State University, 231 West 18th Avenue, Columbus, Ohio 43210-1174, or call 614-292-5279.

Information Distribution: A table is set up in the registration area of Joint Mathematics Meetings for dissemination of information of a **nonmathematical** nature of possible interest to the members.

A second table is set up in the exhibit area for the dissemination of information of a **mathematical** nature not promoting a product or program for sale.

If a person or group wishes to display information of a mathematical nature promoting a product or program for sale, they may do so in the exhibit area at the Joint Books, Journals and Promotional Materials exhibit for a fee of \$30 per item.

If a person or group would like to display material in the exhibit area separate from the Joint Books table, the proponent must reimburse the AMS and MAA for any extra furnishings requested (tables, chairs, easels, etc.) in addition to payment of the \$30 per item fee.

The administration of these tables is in the hands of the AMS-MAA Joint Meetings Committee, as are all arrangements for Joint Mathematics Meetings. The following rules and procedures apply.

1. Announcements submitted by participants should ordinarily be limited to a single sheet no more than $8\frac{1}{2}'' \times 14''$.

2. A copy of any announcement proposed for either table is to be sent to the Director of Meetings, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940 to arrive at least one week before the first day of the scientific sessions.

3. The judgment on the suitability of an announcement for display rests with the Joint Meetings Committee. It will make its judgments on a case-by-case basis to establish precedents.

4. Announcements of events competing in time or place with the scheduled scientific program will not be accepted.

5. Copies of an accepted announcement for either table are to be provided by the proponent. Announcements are not to be distributed in any other way at the meetings (for example, not by posting or personal distribution of handbills).

6. It may be necessary to limit the number of events or the quantity of announcements distributed at a meetings.

7. At the close of registration, both tables will be swept clean. Therefore, a proponent who wishes the return of extra copies should remove them before the close of registration.

Mail: All mail and telegrams for persons attending the meetings should be addressed as follows: Name of Participant, Joint Mathematics Meetings, c/o Department of Mathematics, Ohio State University, Columbus, OH 43210. Mail and telegrams so addressed may be picked up at the mailbox outside the registration area. U.S. mail not picked up will be forwarded after the meetings to the mailing address given on the participant's registration record.

Telephone Messages: A telephone message center is located in the registration area to receive incoming calls for participants. **The center is open from August 8 through August 11, during the hours that the Joint Mathematics Meetings registration desk is open.** Messages will be taken and the name of any individual for whom a message has been received will be posted until the message has been picked up at the message center. Once the registration desk is closed for the day there is no mechanism for contacting participants other than calling them directly at their hotel or residence hall. The telephone number of the message center is 614-294-1615.

Travel: Port Columbus International Airport is located about 12 miles east of the campus. Taxi service is available from the airport to the campus area for approximately \$18-\$22. There is also an Airport Shuttle stop outside the lower baggage claim area. Cost is \$5 per person to the university area.

Rental car agencies are located in the lower baggage claim area.

Columbus is serviced by Greyhound and Trailways bus lines. The bus station is located downtown, 2 blocks

taxi ride from the campus area (\$6-\$12).

For some years now, the AMS-MAA Joint Meetings Committee has engaged a travel agent for the January and August Joint Meetings in an effort to ensure that everyone attending these meetings is able to obtain the best possible airfare. This service is being performed by TRAVCON; their advertisement can be found elsewhere in this meeting announcement. Although any travel agent can obtain Supersaver or other such published promotional fares, only TRAVCON can obtain the special additional 5% discount over and above these fares, and the 45% off regular coach fare. The latter, of course, is financially beneficial only when one does not qualify for one of the promotional fares. Participants should pay particular attention to the policies stated in the ad.

Weather: Columbus has a moderate climate with four distinct seasons. Average temperature for August is 84°F for the high and 63° for the low. Average precipitation (in inches) for the month of August is 2.07.

Local Arrangements Committee

The members of the Local Arrangements Committee are Frank Carroll, W. Wistar Comfort (ex-officio), Joseph C. Ferrar, J. William Friel, William H. Jaco (ex-officio), James R. Leitzel (chair), Carolyn Mahoney, Kenneth A. Ross (ex-officio), and Andrew Sterrett.



Committee on the Agenda for Business Meetings

The Society has a Committee on the Agenda for Business Meetings. The purpose is to make Business Meetings orderly and effective. The committee does not have legal or administrative power. It is intended that the committee consider what may be called "quasi-political" motions. The committee has several possible courses of action on a proposed motion, including but not restricted to

- (a) doing nothing;
- (b) conferring with supporters and opponents to arrive at a mutually accepted amended version to be circulated in advance of the meeting;
- (c) recommending and planning a format for debate to suggest to a Business Meeting;
- (d) recommending referral to a committee;
- (e) recommending debate followed by referral to a committee.

There is no mechanism that requires automatic submission of a motion to the committee. However, if a motion has not been submitted through the committee, it may be thought reasonable by a Business Meeting to refer it rather than to act on it without benefit of the advice of the committee.

The committee consists of M. Salah Baouendi, Robert M. Fossum (chairman), and Carol L. Walker.

In order that a motion for the Business Meeting of August 10, 1990, receive the service offered by the committee in the most effective manner, it should be in the hands of the secretary by July 10, 1990.

Robert M. Fossum, Secretary

Petition Table

At the request of the AMS Committee on Human Rights of Mathematicians, a table will be made available in the meetings registration area at which petitions on behalf of named individual mathematicians suffering from human rights violations may be displayed and signed by meetings participants acting in their individual capacities.

Signs of moderate size may be displayed at the table, but must not represent that the case of the individual in question is backed by the Committee on Human Rights unless it has, in fact, so voted. Volunteers may be present at the table to provide information on individual cases, but notice must be sent at least seven (7) days in advance of the meetings to the Director of Meetings in Providence (telephone 401-455-4137). Since space is limited, it may also be necessary to limit the number of volunteers present at the table at any one time. The Committee on Human Rights may delegate a person to be present at the table at any or all times, taking precedence over other volunteers.

Any material which is not a petition (e.g., advertisements, résumés) will be removed by the staff. When registration closes, any material on the table will be discarded, so individuals placing petitions on the table should be sure to remove them prior to the close of registration.



JOINT MATHEMATICS MEETINGS SPECIAL AIRFARES

1-800-999-9780

TRAVCON, INC., the official travel management firm for the Joint Mathematics Meetings to be held in Columbus, Ohio, August 8-11, 1990, has arranged for **special discounts aboard American Airlines and Delta Air Lines.***

Save 5% off the lowest published promotional fares, meeting all restrictions, or 45% off regular roundtrip coach fares, with a seven day advance purchase. The lowest fares require a Saturday night stay, are subject to airline change/cancellation penalties, and must be purchased at least 14 days prior to departure. **These discounted fares can only be obtained through TRAVCON, INC.**

Each Joint Mathematics Meetings participant will also receive \$100,000 flight insurance with each ticket purchased through TRAVCON, INC. aboard any airline.

* Both American Airlines and Delta Air Lines have been designated as the official airline carriers for the Columbus Meeting because they provide the most convenient service for the majority of participants from across the country. However, if American and Delta do not provide convenient service from your area, TRAVCON will inform you of the most convenient flights and lowest available airfare on other airlines.

**Call Today Toll-Free and Save:
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**TRAVCON, INC.
65 LaSalle Road, Suite 300
West Hartford, CT 06107
(203) 232-9939**

Timetable

(Eastern Daylight Time)

The purpose of this timetable is to provide assistance to preregistrants in the selection of arrival and departure dates. The program, as outlined below, is based on information at press time.

AMS SHORT COURSE SERIES

COMBINATORIAL GAMES

Monday,
August 6

MORNING

8:00 a.m. - 2:30 p.m.

SHORT COURSE REGISTRATION
Outside Conference Theatre, Ohio Union

9:00 a.m. - 10:15 a.m.

SHORT COURSE LECTURE #1
What is a game?
Richard K. Guy

10:45 a.m. - noon

SHORT COURSE LECTURE #2
Numbers and games
John H. Conway

AFTERNOON

2:00 p.m. - 3:15 p.m.

SHORT COURSE LECTURE #3
Impartial games
Richard K. Guy

3:45 p.m. - 5:00 p.m.

SHORT COURSE LECTURE #4
More ways of combining games
John H. Conway

5:00 p.m. - 5:30 p.m.

SHORT COURSE DISCUSSION
PERIOD

Tuesday,
August 7

American
Mathematical Society

Mathematical
Association of America

Other
Organizations

MORNING

8:30 a.m. - 4:00 p.m.

BOARD OF GOVERNORS' MEETING

9:00 a.m. - 10:15 a.m.

SHORT COURSE LECTURE #5
Hot games, including Go
Elwyn R. Berlekamp

10:45 a.m. - noon

SHORT COURSE LECTURE #6
Codes and games
Vera S. Pless

AFTERNOON

2:00 p.m. - 3:15 p.m.

SHORT COURSE LECTURE #7
Complexity of games
Aviezri S. Fraenkel

2:00 p.m. - 7:00 p.m.

COUNCIL MEETING

3:00 p.m. - 7:00 p.m.

REGISTRATION FOR JOINT MATHEMATICS MEETINGS
Main Lounge, Ohio Union

**Tuesday,
August 7 (cont'd)**

American
Mathematical Society

Mathematical
Association of America

Other
Organizations

AFTERNOON (cont'd)

3:45 p.m. - 5:00 p.m.

SHORT COURSE LECTURE #8
*Welter's game, dots-and-boxes and
Sylver Coinage*
Richard J. Nowakowski

4:00 p.m. - 6:00 p.m.

SECTION OFFICERS' MEETING

5:00 p.m. - 5:30 p.m.

SHORT COURSE DISCUSSION
PERIOD

EVENING

6:30 p.m. - 7:30 p.m.

RECEPTION FOR 25-YEAR MEMBERS

8:15 p.m. - 10:00 p.m.

NATIONAL MEETING OF DEPARTMENT HEADS

**Wednesday,
August 8**

American
Mathematical Society

Mathematical
Association of America

Other
Organizations

MORNING

7:30 a.m. - 4:00 p.m.

REGISTRATION
Main Lounge, Ohio Union

8:30 a.m. - 9:30 a.m.

★ ★ ★ **MAA DAY** ★ ★ ★

9:55 a.m. - 10:45 a.m.

OPENING CEREMONIES

10:55 a.m. - 11:00 a.m.

FIRST INVITED ADDRESS
*The Seventy-Fifth Anniversary
Celebration*
G. Baley Price

11:10 a.m. - noon

PLAQUE CEREMONY

SECOND INVITED ADDRESS
*Was Newton's calculus just a dead end?
Maclaurin and the Scottish connection*
Judith V. Grabiner

AFTERNOON

1:00 p.m. - 5:00 p.m.

EXHIBIT AND BOOK SALE

BOOK SALE

1:00 p.m. - 5:00 p.m.

EXHIBITS

**Wednesday,
August 8 (cont'd)**

AFTERNOON (cont'd)

1:30 p.m. - 2:00 p.m.

INVITED ADDRESS

*Mathematics and computation:
Proliferation and fragmentation*
Wade Ellis, Jr.

2:10 p.m. - 2:40 p.m.

INVITED ADDRESS

*Has progress in mathematics slowed
down?*
Paul R. Halmos

2:50 p.m. - 3:20 p.m.

INVITED ADDRESS

*The contribution of mathematics to
education*
Peter J. Hilton

3:30 p.m. - 4:00 p.m.

INVITED ADDRESS

*The last 75 years: Glants of applied
mathematics*
Cathleen S. Morawetz

4:15 p.m. - 4:30 p.m.

TAKING OF GROUP PICTURE

4:45 p.m. - 5:45 p.m.

MATHEMATICAL CIRCUS

EVENING

6:00 p.m. - 7:00 p.m.

**MAA STUDENT CHAPTERS/PME
RECEPTION**

7:00 p.m. - 10:00 p.m.

MAA 75TH ANNIVERSARY CELEBRATION BANQUET

**Thursday,
August 9**

MORNING

7:30 a.m. - 4:00 p.m.

REGISTRATION
Main Lounge, Ohio Union

8:00 a.m. - 8:30 a.m.

**SPECIAL PRESENTATION ON
SCULPTURING**
Helaman Ferguson

8:00 a.m. - 10:00 a.m.

MINICOURSE #1 (Part A)
*Using metacognitive strategies to
improve instruction*
Genevieve Knight

MINICOURSE #2 (Part A)
*Planning, funding, and administering
teacher enhancement projects*
T. Christine Stevens

**Thursday
August 9 (cont'd)**

 American
Mathematical Society

 Mathematical
Association of America

 Other
Organizations

MORNING (cont'd)

8:00 a.m. - noon

 SPECIAL SESSIONS

SESSIONS FOR CONTRIBUTED
PAPERS

 CUPM SUBCOMMITTEE ON
SYMBOLIC COMPUTER SYSTEMS
POSTER SESSION
Symbolic computation
Joan R. Hundhausen (organizer)

 CONTRIBUTED PAPER SESSION
*The interface between mathematics and
operations research, Part A*
Linn I. Sennott

8:50 a.m. - 9:40 a.m.

 AAAS-MAA INVITED ADDRESS
Lost and found mathematics
Richard Askey

8:50 a.m. - 9:40 a.m.

 CUPM SUBCOMMITTEE ON
QUANTITATIVE LITERACY REQUIRE-
MENTS PANEL DISCUSSION
Quantitative literacy
JoAnne S. Growney
Linda R. Sons (chair)

 ASSOCIATION FOR
WOMEN IN MATHEMATICS
PANEL DISCUSSION

9:00 a.m. - 10:00 a.m.

9:00 a.m. - 10:30 a.m.

 STUDENT CHAPTER PANEL
DISCUSSION
Aparna W. Higgins (organizer)

9:00 a.m. - 5:00 p.m.

EXHIBIT AND BOOK SALE

BOOK SALE

9:00 a.m. - 5:00 p.m.

EXHIBITS

9:55 a.m. - 10:45 a.m.

 AMS-MAA INVITED ADDRESS
*Algebra as a means of understanding
mathematics*
Saunders Mac Lane

10:15 a.m. - 12:15 p.m.

 MINICOURSE #3 (Part A)
A seminar on women in mathematics
Miriam P. Cooney csc

 MINICOURSE #4 (Part A)
A calculus laboratory using Mathematica
Michael Barry
Benjamin Haytock
Richard McDermot

 MINICOURSE #5 (Part A)
Using history in teaching calculus
V. Frederick Rickey

 AWM MEMBERSHIP MEETING
AND PRIZE SESSION

10:15 a.m. - 10:45 a.m.

Thursday,
August 9 (cont'd)

American
Mathematical Society

Mathematical
Association of America

Other
Organizations

MORNING (cont'd)

11:00 a.m. - 11:50 a.m.

NCTM-MAA INVITED ADDRESS
*Mathematics education - yesterday,
today, and tomorrow*
John A. Dossey

AFTERNOON

noon - 1:00 p.m.

NATIONAL SCIENCE FOUNDATION
Informal Discussion Group

1:15 p.m. - 2:15 p.m.

EARLE RAYMOND HEDRICK
LECTURE I
*Spirals from Theodorus of Cyrene to
meta-chaos. Spirals: Old and new*
Philip J. Davis

2:30 p.m. - 3:20 p.m.

MAA-PME INVITED ADDRESS
Problems for all seasons
Ivan Niven

2:30 p.m. - 4:00 p.m.

CUPM SUBCOMMITTEE ON
SYMBOLIC COMPUTER SYSTEMS
PANEL DISCUSSION
*The pedagogical impact of computer
algebra systems on college
mathematics curricula*
William Boyce
John Harvey
Michael Henle
Robert J. Lopez (organizer)
Jeanette Palmiter

2:30 p.m. - 4:30 p.m.

MINICOURSE #1 (Part B)
*Using metacognitive strategies to
improve instruction*
Genevieve Knight

2:30 p.m. - 6:00 p.m.

MINICOURSE #2 (Part B)
*Planning, funding, and administering
teacher enhancement projects*
T. Christine Stevens

CONTRIBUTED PAPER SESSION
*The interface between mathematics
and operations research, Part B*
Linn I. Sennott

CONTRIBUTED PAPER SESSION
*Toward equity and excellence:
Efforts to increase the number of
minorities and women in the profession,*
Part A
Carolyn R. Mahoney

PI MU EPSILON CONTRIBUTED
PAPER SESSIONS

TIME TABLE

**Thursday,
August 9 (cont'd)**

American
Mathematical Society

Mathematical
Association of America

Other
Organizations

AFTERNOON (cont'd)

3:35 p.m. - 5:05 p.m.

PROGRESS IN MATHEMATICS
LECTURE
*Viscosity solutions of partial differential
equations*
Michael G. Crandall

4:30 p.m. - 5:20 p.m.

SPECIAL LECTURE
The art of mental calculation
Arthur Benjamin

4:30 p.m. - 5:20 p.m.

CUPM SUBCOMMITTEE ON
SYMBOLIC COMPUTER SYSTEMS
SPECIAL PRESENTATION
*Symbolic computing in undergraduate
mathematics: symbols, pictures,
numbers, and insights*
Paul Zorn

4:45 p.m. - 6:45 p.m.

MINICOURSE #3 (Part B)
A seminar on women in mathematics
Miriam P. Cooney

MINICOURSE #4 (Part B)
A calculus laboratory using Mathematica
Michael Barry
Benjamin Haytock
Richard McDermot

MINICOURSE #5 (Part B)
Using history in teaching calculus
V. Frederick Rickey

EVENING

6:30 p.m. - 8:15 p.m.

PME BANQUET

6:30 p.m. - 7:30 p.m.

7:30 p.m. - 9:00 p.m.

AMS-MAA-MSEB EVENING OF DIALOGUE

OPEN RECEPTION

SESSION ON MATHEMATICS EDUCATION

Elaine Hariston, presider
Main Speaker To Be Announced
Lida K. Barrett, respondent
William Browder, respondent

8:30 p.m. - 9:30 p.m.

PME J. SUTHERLAND FRANKS
LECTURE
Title to be announced
Ronald L. Graham

9:30 p.m. - 11:00 p.m.

AWM RECEPTION

TIMETABLE

Friday,
August 10

MORNING

7:30 a.m. - 4:00 p.m.

8:00 a.m. - 10:50 a.m.

8:00 a.m. - 9:30 a.m.

8:00 a.m. - 9:00 a.m.

8:30 a.m. - 10:30 a.m.

8:50 a.m. - 9:40 a.m.

9:00 a.m. - 10:50 a.m.

American
Mathematical SocietyMathematical
Association of AmericaOther
OrganizationsREGISTRATION
Main Lounge, Ohio Union

SPECIAL SESSIONS

SESSIONS FOR CONTRIBUTED
PAPERS

CONTRIBUTED PAPER SESSION

Liberal arts mathematics courses, Part A
Solomon A. Garfunkel

CONTRIBUTED PAPER SESSION

*Toward equity and excellence: Efforts
to increase the number of minorities
and women in the profession, Part B*
Carolyn R. Mahoney

STUDENT CHAPTERS' SESSION

Modeling
Ben A. Fusaro (organizer)MINICOURSE #6 (Part A)
Writing to learn mathematics
Agnes AzzolinoMINICOURSE #7 (Part A)
*Exploring mathematics with the NeXT
computers*
Charles G. Fleming
Judy D. HalchinMINICOURSE #8 (Part A)
*A mathematician's introduction to the
HP-48SX scientific expandable
calculator for first-time users*
John Kenelly
Don LaTorreMINICOURSE #9 (Part A)
*Starting, funding and sustaining
mathematics laboratories*
James E. White

INVITED ADDRESS

The role of microlocal analysis in PDE
Michael E. TaylorCOMMITTEE ON COMPUTERS IN
MATHEMATICS EDUCATION PANEL
DISCUSSION
Visualization project
Herman E. Gollwitzer
Valerie A. Miller
Walter Zimmermann (moderator)PME DUTCH TREAT
BREAKFAST

TIME TABLE

**Friday,
August 10 (cont'd)**

American
Mathematical Society

Mathematical
Association of America

Other
Organizations

MORNING (cont'd)

9:00 a.m. - 10:50 a.m.

COMMITTEE ON THE TEACHING OF
UNDERGRADUATE MATHEMATICS
PANEL DISCUSSION
*Research in learning undergraduate
mathematics*
Lida K. Barrett (moderator)
Joan Ferrini-Mundy
James J. Kaput

9:00 a.m. - 5:00 p.m.

EXHIBIT AND BOOK SALE

BOOK SALE

9:00 a.m. - 5:00 p.m.

EXHIBITS

9:15 a.m. - 10:50 a.m.

PME CONTRIBUTED PAPER
SESSIONS

9:55 a.m. - 10:45 a.m.

INVITED ADDRESS
*Statistical mechanics of Coulomb
systems*
Joseph G. Conlon

11:05 a.m. - noon

PRIZE SESSION AND
BUSINESS MEETING

AFTERNOON

noon - 1:00 p.m.

NATIONAL SCIENCE FOUNDATION
Informal Discussion Group

12:15 p.m. - 1:15 p.m.

PME COUNCIL

1:15 p.m. - 2:15 p.m.

EARLE RAYMOND HEDRICK
LECTURE II
*Spirals from Theodorus of Cyrene to
meta-chaos. Lessons from Euler*
Philip J. Davis

2:30 p.m. - 3:20 p.m.

CMS-MAA INVITED ADDRESS
Prime number records
Paulo Ribenboim

2:30 p.m. - 4:30 p.m.

MINICOURSE #6 (Part B)
Writing to learn mathematics
Agnes Azzolino

MINICOURSE #7 (Part B)
*Exploring mathematics with the NeXT
computer*
Charles G. Fleming
Judy D. Halchin

MINICOURSE #9 (Part B)
*Starting, funding and sustaining
mathematics laboratories*
James E. White

TIMETABLE

Friday, August 10 (cont'd)	American Mathematical Society	Mathematical Association of America	Other Organizations
AFTERNOON (cont'd)	SPECIAL SESSIONS SESSIONS FOR CONTRIBUTED PAPERS	CONTRIBUTED PAPER SESSION <i>Liberal arts mathematics courses, Part B</i> Solomon A. Garfunkel	PME CONTRIBUTED PAPER SESSIONS
2:30 p.m. - 4:50 p.m.		MAA-SIAM INVITED ADDRESS <i>Interior point methods for linear programming: An overview</i> Richard Tapia	
3:35 p.m. - 4:25 p.m.			
3:50 p.m. - 4:50 p.m.		OPEN DISCUSSION ON CONSULTANTS John W. Kenelly Richard Millman Alan C. Tucker	
5:05 p.m. - 6:00 p.m.		PRIZE SESSION AND BUSINESS MEETING	
EVENING			
6:30 p.m. - 9:00 p.m.	COMMITTEE ON SCIENCE POLICY PANEL DISCUSSION	SOCK HOP	
8:00 p.m. - 10:00 p.m.			
Saturday, August 11	American Mathematical Society	Mathematical Association of America	Other Organizations
MORNING			
7:30 a.m. - 1:00 p.m.		REGISTRATION Main Lounge, Ohio Union	
8:00 a.m. - 10:00 a.m.		MINICOURSE #6 (Part C) <i>Writing to learn mathematics</i> Agnes Azzolino	
8:00 a.m. - noon	SPECIAL SESSIONS SESSIONS FOR CONTRIBUTED PAPERS	MINICOURSE #10 (Part A) <i>CAS laboratory projects for calculus</i> Carl Leinbach	
8:50 a.m. - 9:40 a.m.		ACM-MAA INVITED ADDRESS <i>On the computational complexity of doing mathematics</i> Juris Hartmanis	

TIMETABLE

**Saturday,
August 11 (cont'd)**

American
Mathematical Society

Mathematical
Association of America

Other
Organizations

MORNING (cont'd)

9:00 a.m. - 10:20 a.m.

CUPM SUBCOMMITTEE ON
AND THE FIRST TWO YEARS PANEL
DISCUSSION
Calculus reform today: an overview
Thomas W. Tucker (chair)

9:00 a.m. - noon

EXHIBIT AND BOOK SALE

BOOK SALE

9:00 a.m. - noon

EXHIBITS

9:55 a.m. - 10:45 a.m.

MAA-NAM INVITED ADDRESS
*Intriguing problems about zeros
in complex analysis*
Carl Prather

10:15 a.m. - 12:15 p.m.

MINICOURSE #11 (Part A)
*Producing mathematics courseware with
Mathematica: Calculus and Mathematica*
Don Brown
Horacio Porta
Jerry Uhl

MINICOURSE #12
*Exploring statistics and discrete
mathematics topics using inexpensive
graphing calculators*
Franklin Demana
Bert K. Waits

MINICOURSE #13 (Part A)
*Spreadsheet based mathematical topics
for nonmathematics majors*
V.S. Ramamurti

10:30 a.m. - noon

SCIENCE POLICY COMMITTEE PANEL
DISCUSSION
State mathematics coalitions
Marjorie Enneking
Robert Kansky
Harvey B. Keynes (moderator)

10:30 p.m. - 12:20 p.m.

MAA STUDENT CHAPTERS/PME
CONTRIBUTED PAPER SESSION

11:00 a.m. - 11:50 a.m.

AWM-MAA INVITED ADDRESS
The uses of set theory
Judith Roitman

AFTERNOON

noon - 1:00 p.m.

NATIONAL SCIENCE FOUNDATION
Informal Discussion Group

TIMETABLE

Saturday,
August 11 (cont'd)

MORNING (cont'd)

1:00 p.m. - 3:20 p.m.

1:00 p.m. - 3:00 p.m.

1:15 p.m. - 2:15 p.m.

2:30 p.m. - 3:20 p.m.

3:15 p.m. - 5:15 p.m.

3:35 p.m. - 5:05 p.m.

3:35 p.m. - 4:25 p.m.

American
Mathematical Society

SPECIAL SESSIONS

SESSIONS FOR CONTRIBUTED
PAPERS

PROGRESS IN MATHEMATICS
LECTURE

A-trees and their applications
John W. Morgan

Mathematical
Association of America

MINICOURSE #8 (Part B)
*A mathematician's introduction to the
HP-48SX scientific expandable
calculator for first-time users*
John Kenelly
Don LaTorre

MINICOURSE #10 (Part B)
CAS laboratory projects for calculus
Carl Leinbach

EARLE RAYMOND HEDRICK
LECTURE III
*Spirals from Theodorus of Cyrene to
meta-chaos. Theodorus goes wild*
Philip J. Davis

AMATYC-MAA INVITED ADDRESS
*Crisis in mathematics education:
perspective from the two-year college*
Karl J. Smith

MINICOURSE #11 (Part B)
*Producing mathematics courseware
with Mathematica: Calculus and
Mathematica*
Don Brown
Horacio Porta
Jerry Uhl

MINICOURSE #13 (Part B)
*Spreadsheet based mathematical
topics for nonmathematics majors*
V. S. Ramamurti

COMMITTEE ON THE PARTICIPATION
OF WOMEN SPECIAL LECTURE
History of women in the MAA
Judy Green

Other
Organizations

American Mathematical Society Short Course Series
Introductory Survey Lectures on
Combinatorial Games
Columbus, Ohio, August 6-7, 1990

The American Mathematical Society, in conjunction with its ninety-third Summer Meeting, will present a two day Short Course entitled "Combinatorial Games" on Monday and Tuesday, August 6-7, 1990, at the Ohio State University, Columbus, Ohio. The program is under the direction of Richard K. Guy, The University of Calgary.

The course is designed to be a self-contained introduction to combinatorial games. The subject is both new and extensive, and the organizer has been selective in the topics treated. The area grew from parts of recreational mathematics, but has fast developed into a serious area of study, with close connections with other branches of combinatorics – graph theory, coding theory, networks, complexity – and surreal numbers. It is not the classical game theory of von Neumann and Morgenstern; the games are *completely determined*; there is complete information and there are no chance moves.

Monday, August 6:

RICHARD K. GUY, University of Calgary, *What is a game?*

JOHN H. CONWAY, Princeton University, *Numbers and games*

RICHARD K. GUY, *Impartial games*

JOHN H. CONWAY, *More ways of combining games*

Tuesday, August 7:

ELWYN R. BERLEKAMP, University of California, Berkeley, *Hot games, including Go*

VERA PLESS, University of Illinois at Chicago, *Codes and Games*

AVIEZRI S. FRAENKEL, Weizmann Institute of Science, *Complexity of games*

RICHARD J. NOWAKOWSKI, Dalhousie University *Welter's game, Dots-and-Boxes and Sylver Coinage*

Synopses of the talks and accompanying reading lists follow. Lecture notes will be mailed to those who preregister and will be available at the Short Course registration desk for those registering on site.

The course will be self-contained but participants may wish to consult *Winning Ways* (Berlekamp, Conway, Guy; Academic Press, 1982) or *On Numbers and Games* (Conway; Academic Press, 1976).

Advance registration fee: \$40 (\$15 student/unemployed). Onsite registration fee: \$50 (\$20 student/unemployed). Registration and housing information can be found in this issue of *Notices*, see sections **Preregistration**

Housing and Registration at the Meetings.

Those who also plan to attend the Summer Meeting should take note of a Special Session on *Combinatorial Games*, organized by Richard J. Nowakowski, Dalhousie University. For more information, see the Special Session section of the Columbus meeting announcement in this issue of *Notices*.

The Short Course series is under the direction of the Short Course Subcommittee of the AMS-MAA Committee on Employment and Educational Policy (CEEP). Stefan A. Burr (chair), R. Peter DeLong, Lisl Novak, Gaal, Robert P. Kurshan, Barbara L. Osofsky, Marjorie L. Stein, and James J. Tattersall.

Synopses and Reading Lists:

What is a game? (Richard K. Guy). In this introductory lecture combinatorial games will be contrasted with classical games. There is complete information and there are no chance moves. They are two-person games, so that there are no coalitions. Positions and options. The ending condition. Normal and misère play. The four outcome classes. General definition of a (combinatorial) game. The games born on day one. Some games are numbers. The Simplicity Rule. Some games are infinitesimal. Stop and Up. The games born on day two. Some games are hot. The negative of a game. Sums of games. Simple examples of games, chosen from Blue-Red Hackenbush, Toads-and-Frogs, and Domineering.

[1] E. R. Berlekamp, J. H. Conway and R. K. Guy, *Winning Ways for your Mathematical Plays*, Academic Press, London and New York, 1982; especially Chapters 1 and 2. WW

[2] J. H. Conway, *On Numbers and Games*, Academic Press, London and New York, 1976; especially Chapter 7. ONAG

Numbers and Games (John H. Conway). I'll show how games can be suitably construed and combined

as to form a group, and how the members of a certain subgroup of this group are properly called **numbers**. The properties of these numbers will then be used to help you to play some easy games and to think about some harder ones.

[1] WW, Chapter 2.

[2] ONAG, Chapter 8.

Impartial Games (Richard K. Guy). The same options are available to both players, regardless of whose turn it is to move, so that there are only two outcome classes. The game of Nim. Nim-addition. Poker Nim. Bogus nim-heaps. The Mex Rule and the Sprague-Grundy theory. Subtraction games. Octal games; Kayles and Dawson's Kayles. Periodicity of nim-values. Sparse spaces and common cosets. Misère Nim and an awful warning.

[1] WW, Chapters 3 and 4.

[2] ONAG, Chapter 11.

[3] Richard K. Guy, Fair Game, COMAP Math. Exploration Series, Arlington MA, 1989. FG

More Ways of Combining Games (John H. Conway). Here I'll talk about some ways of combining games that were *not* discussed in my first lecture. The associated theories are usually complete only for impartial games. Two particular cases are especially interesting.

Selective compounds of partizan games. It is surprising that there is a complete theory here—it depends on the theory of numbers already discussed and on Steinhaus's notion of **remoteness**.

Disjunctive addition of impartial games under misère play. Here the theory, although complete in an abstract sense, is so complicated that special techniques are required to apply it successfully.

[1] WW, Chapters 9, 10 and 13.

[2] ONAG, Chapters 12 and 14.

Hot Games, including Go (Elwyn R. Berlekamp). Go is a classical Oriental board game in which Black and White place stones onto the nodes of a board and attempt to enclose territory and/or capture opposing stones by surrounding them. In late-stage Go endgames, the board can often be partitioned into several disjoint areas, such that each subsequent move affects only the area within which it is played. In this sense, a typical late-stage Go endgame can be naturally decomposed into a sum of more elementary games.

Although the winner of a game of Go is defined as the player with the larger score we are able to define a very similar game called Mathematical Go, in which passing is illegal and the winner is the player who succeeds in making the last legal move. Although the scoring rules for Mathematical Go appear to be very different from versions of the game, it turns out that, under appropriate conditions which occur very often in practice, all of these different sets of rules agree on who wins. It is therefore possible to convert winning strategies for many

Mathematical Go endgames into winning strategies for the corresponding endgames played and scored according to conventional rules.

An elaborate theory has been developed which facilitates precise analyses of Mathematical Go endgames. A homomorphism called "chilling" (a special case of "cooling") reduces many Go endgames to familiar numbers and infinitesimals which occur commonly in many of the games that were presented and solved in *Winning Ways*. A generalized "overheating" operator often inverts the "chilling" transformation.

To illustrate the power of these techniques, we have composed an appropriate collection of Go endgame problems, which can be readily solved by these mathematical methods, but which have proved very difficult for expert Go players. The typical such problem on a 19×19 Go board has about twenty disjoint active areas of play. Typically, the best move within each such area is "obvious" to any good Go player, but the selection of which area in which to play next is much more subtle. A well-played game starting from one of these conventional Go endgame problems lasts about forty moves, and White wins by one point. Victory requires careful and precise play throughout the endgame. Many excellent Go players fail to see the distinctions between the many plausible moves; they typically assume that many of these moves are equally good, when in fact only a very small number of the plausible moves are good enough to win against a mathematically proficient gamesman playing Black.

[1] WW, Chapter 6.

[2] ONAG, Chapter 9.

Codes and Games (Vera Pless). The subject of error-correcting codes arose approximately forty years ago in response to practical problems in the reliable communication of digitally encoded information. Since then a substantial mathematical theory of coding has been developed [6]. In this process many unforeseen relationships with other parts of mathematics were discovered. Some coding theorists are accustomed to call on results from group theory, the theory of combinatorial designs, lattices and sphere packings to name a few areas related to coding theory. It is gratifying also that results and constructions from coding theory have proven useful in many related areas. The relations between combinatorial games and coding theory are relatively new [1] Chapter 14, and [4].

We give an introduction to error-correcting codes with emphasis on binary codes. We describe in detail three famous, practical codes and their extended codes; the (7, 4, 4) and (8, 4, 4) Hamming codes, the (17, 9, 5) and (18, 9, 6) quadratic residue codes and the (23, 12, 7) and (24, 12, 8) Golay codes. These codes are related to some of Lenstra's coin-turning games. In fact, the winning moves in these games coincide with the codewords in their corresponding codes. We describe the

combinatorial designs contained in these codes and also the codes' groups. All of these codes can be described as quadratic residue codes [6]. The group of the famous (24, 12, 8) code C is the Mathieu group. Codewords in C , and hence winning moves in 24 coin Mogul, can be found by means of the MOG [5].

All of the codes given above are lexicodes. These are a new class of codes whose theory is closely related to the theory of certain impartial games [4]. They are constructed by a greedy algorithm similar to the calculation of nim-values. Constant weight binary lexicodes with minimal distance 4 are related to Welter's games.

[1] WW, Chapter 14.

[2] -

[3] FG, pages 59-70.

[4] J. H. Conway and N. J. A. Sloane, *Lexicographic codes: error-correcting codes from game theory*, IEEE Trans. Info. Theory, IT-32, No. 3 (1986), 337-348.

[5] R. T. Curtis, *A new combinatorial approach to M24*, Math. Proc. Comb. Phil. Soc., (1976), 25-42.

[6] V. Pless, *Introduction to the Theory of Error-Correcting Codes*, second edition, John Wiley and Sons, New York, 1989.

Complexity of Games (Aviezri S. Fraenkel). We restrict attention to the class of 2-player games with perfect information (no hidden information as in some card games) and no chance moves (no dice), with outcome restricted to Lose, Win and Draw. The complexity level of even this restricted class varies greatly: while Nim has a trivial winning strategy, Chess, another family-member, has been challenging people's minds for centuries. In Nim, a finite number of piles of tokens is given. The two players alternate in selecting a pile, removing from it any positive number of tokens. The player making the last move wins. Features of Chess not present in Nim include: cycles (repeated positions), capture rules of tokens and partizanship of moves (White can't move a Black piece). Introducing these features one by one on top of Nim rather than simultaneously, leads to a spectrum of new games of increasing complexity, spanning the gap between Nim-type and Chess-type games. It also serves to fix some points on the games complexity map, especially on a number of scenic highways leading from Nim to Chess. The talk will review the classical Sprague-Grundy theory, governing Nim-type games, and then sketch its generalization to permit handling cycles (potential draws). Even adding special capture rules on top of cycles preserves polynomiality, but many capture rules and partizan moves lead to Pspace-hard and even Extime-complete and Exspace-complete games. In existential problems such as the Traveling Salesman problem,

high complexity is a liability; in games and cryptography it can be an asset.

[7] C. Berge, *Graphs*, North-Holland, Amsterdam 1981 (Ch.14).

[8] A. S. Fraenkel and D. Lichtenstein, *Computing a perfect strategy for $n \times n$ chess requires time exponential in n* , J. Combinatorial Theory (Ser.A), vol. 31 (1981), pp. 199-214.

[9] A. S. Fraenkel and Y. Yesha, *The generalized Sprague-Grundy function and its invariance under certain mappings*, J. Combinatorial Theory (Ser.A), vol. 43 (1986), pp. 165-177.

[10] M. R. Garey and D. S. Johnson, *Computers and intractability: A Guide to the Theory of NP-Completeness*, Freeman, San Francisco 1979 (Appendix A8).

[11] D. S. Johnson, *Games and puzzles (The NP-completeness column: an ongoing guide*, 9th edition), J. of Algorithms, vol. 4 (1983), pp. 397-411.

[12] S. Reisch, *Hex ist PSPACE-vollständig*, Acta Informatica, vol. 15 (1981), pp. 167-191.

[13] L. J. Stockmeyer and A. K. Chandra, *Provably difficult combinatorial games*, SIAM J. Computing, vol. 8 (1979), pp. 151-174.

Welter's Game, Dots-and-Boxes and Sylver Coinage (Richard J. Nowakowski). An overview of three surprisingly complicated two-player games. Welter's Game is played on a semi-infinite strip of squares. There is a finite number of coins on the strip, with at most one per square. A legal move for either player is to move a coin to an empty square to its left. A player who cannot move loses. The game is like Nim — each occupied square corresponds to a pile of counters but now no two piles can have the same number. The analysis required to determine a winning move leads naturally to considering *frieze patterns* with nim-addition. Dots and Boxes is played on a rectangular array of dots. Players take turns in joining either two horizontally or two vertically adjacent dots. When a player completes a unit square (box) she initials it and must draw another line. The game ends at the end of the game with the most boxes wins. The game can be played at various levels of sophistication. The third level (after 'greedy' and 'not-so-greedy') depends on analyzing 2 by n arrays with the last-player-to-move wins rule. In Sylver Coinage the players take turns choosing positive integers that are not positive linear combinations of some previously chosen numbers. The game is finite but the number of moves is unbounded. Choosing 5 is a winning first move but what do you choose if your opponent chooses 100000001? There are many open questions!

[1] WW, Chapters 15, 16 and 18.

[2] ONAG, Chapter 13.

[3] FG, pages 71-80.

Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

Columbus, OH, August 1990

Joseph G. Conlon	John Morgan
Michael G. Crandall	(Progress in Mathematics Lecture)
(Progress in Mathematics Lecture)	Michael E. Taylor
Saunders Mac Lane (AMS-MAA)	

Amherst, MA, October 1990

Christopher B. Croke	John J. Mallet-Paret
William M. Goldman	Henry P. McKean, Jr.

Denton, TX, November 1990

Avner D. Ash	John Luecke
Peter S. Constantin	Clarence W. Wilkerson

San Francisco, CA, January 1991

Michael F. Atiyah	Kenneth A. Ribet
(Gibbs Lecturer)	Héctor J. Sussmann
Maria M. Klawe	

Invited addresses at Sectional Meetings are selected by the Section Program Committee, usually twelve to eighteen months in advance of a meeting. Members wishing to nominate candidates for invited addresses should send the relevant information to the Associate Secretary for the Section who will forward it to the Section Program Committee.

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes

the timetable for announcing the existence of Special Sessions.

August 1990 Meeting in Columbus, Ohio

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: April 27, 1990

Susan Jane Colley and Gary Kennedy, *Algebraic geometry*
Zita M. Divis and David Terman, *Dynamics of biological systems*

Thomas A. Dowling, Dijen Ray-Chaudhuri and Neil Robertson, *Combinatorics*

Richard K. Guy and Richard J. Nowakowski, *Combinatorial games*

S. K. Jain and S. Tariq Rizvi, *Ring theory*

Surinder K. Sehgal and Ronald Solomon, *Group theory*

October 1990 Meeting in Amherst, Massachusetts Eastern Section

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: July 16, 1990

Colin C. Adams, *Hyperbolic manifolds*

M. K. Bennett and Garrett Birkhoff, *Lattices, geometry, and combinatorics*

Melvyn S. Berger and Robert A. Gardner, *Non-linear dynamics in mathematics and science*

Haskell Cohen, *Semigroups*

William M. Goldman and Bernard Maskit, *Discrete groups and geometric structures in 2, 3 and 4 dimensions*

James E. Humphreys and Ivan Mirković, *Lie groups and algebraic groups*

Chjan C. Lim, *Algebraic graph theory*

V. S. Prasad, *Ergodic theory*

Charles Radin and Marjorie Senechal, *Aperiodicity and order*

November 1990 Meeting in Denton, Texas Central Section

Associate Secretary: Andy Roy Magid

Deadline for organizers: Expired

Deadline for consideration: July 16, 1990

Avner D. Ash and Mark S. Reeder, *Arithmetic groups*
Elizabeth M. Bator, Russell G. Bilyeu and Paul W. Lewis,
Banach spaces-functional analysis
Ilya Bakelman, *Geometric inequalities and convex bodies*
Scott T. Chapman and Nick H. Vaughan, *Commutative
algebra*
Daniel S. Freed, Robert F. Williams and Michael Wolf,
Texas topology and geometry
Anant P. Godbole, *The probability theory of patterns
and runs*
John Luecke and Robert Myers, *Low dimensional topol-
ogy*
Lisa Mantini and Roger C. Zierau, *Representation theory
of Lie groups*
John W. Neuberger and Henry A. Warchall, *Differential
equations*
Peter F. Stiller, *Algebraic geometry*
Emil J. Straube, *Several complex variables*

November 1990 Meeting in Irvine, California
Far Western Section
Associate Secretary: Lance W. Small
Deadline for organizers: Expired
Deadline for consideration: July 16, 1990

January 1991 Meeting in San Francisco, California
Associate Secretary: Andy Roy Magid
Deadline for organizers: April 16, 1990
Deadline for consideration: September 19, 1990

March 1991 Meeting in South Bend, Indiana
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: June 16, 1990
Deadline for consideration: To be announced

March 1991 Meeting in Tampa, Florida
Southeastern Section
Associate Secretary: Joseph A. Cima
Deadline for organizers: June 22, 1990
Deadline for consideration: To be announced

August 1991 Meeting in Orono, Maine
Associate Secretary: Lance W. Small
Deadline for organizers: November 15, 1990
Deadline for consideration: To be announced

October 1991 Meeting in Philadelphia, Pennsylvania
Eastern Section
Associate Secretary: W. Wistar Comfort
Deadline for organizers: January 10, 1991
Deadline for consideration: To be announced

October 1991 Meeting in Fargo, North Dakota
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: January 25, 1991
Deadline for consideration: To be announced

January 1992 Meeting in Baltimore, Maryland
Associate Secretary: W. Wistar Comfort
Deadline for organizers: April 8, 1991
Deadline for consideration: To be announced

March 1992 Meeting in Springfield, Missouri
Central Section
Associate Secretary: Andy Roy Magid
Deadline for organizers: June 26, 1991
Deadline for consideration: To be announced

January 1993 Meeting in San Antonio, Texas
Associate Secretary: Lance W. Small
Deadline for organizers: April 13, 1992
Deadline for consideration: To be announced

**August 1993 Meeting in Vancouver, British Columbia,
Canada**
Associate Secretary: Andy Roy Magid
Deadline for organizers: November 11, 1992
Deadline for consideration: To be announced

January 1994 Meeting in Cincinnati, Ohio
Associate Secretary: Joseph A. Cima
Deadline for organizers: April 5, 1993
Deadline for consideration: To be announced

January 1996 Meeting in Orlando, Florida
Associate Secretary: W. Wistar Comfort
Deadline for organizers: April 12, 1995
Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence. According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the same a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but can be found in "Rules for Special Sessions" on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the PCNM or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the PCNM well in advance of the

meeting and, in any case, at least nine months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to *Notices*, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in *Notices* in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three weeks before the Deadline for Abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. They are selected by the Section Program Committee. The processing of proposals for Special Sessions for Sectional Meetings is handled by the Associate Secretary for the Section, who then forwards the proposals to the Section Program Committee, which makes the final selection of the proposals. Each Invited Speaker at a Sectional Meeting is invited to organize a Special Session. Just as for national meetings, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for and organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

Proposals for Special Sessions to the Associate Secretaries

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)
Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
Electronic mail: g_small@math.ams.com
(Telephone 619-534-3590)

Central Section
Andy Roy Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
Electronic mail: g_magid@math.ams.com
(Telephone 405-325-6711)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
Electronic mail: g_comfort@math.ams.com
(Telephone 203-347-9411)

Southeastern Section

Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
Electronic mail: g_cima@math.ams.com
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Electronic submission of abstracts is now available to those who use the \TeX typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the Abstracts package, users should be sure to specify whether they want the plain \TeX , \AMS-TeX , or the \LaTeX package.

Number of Papers Presented**Joint Authorship**

Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting.

An individual may contribute only one abstract by title in any one issue of *Abstracts*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Site Selection for Sectional Meetings

Sectional Meeting sites are recommended by the Associate Secretary for the Section and approved by the Committee of Associate Secretaries and Secretary. Recommendations are usually made eighteen to twenty-four months in advance. Host departments supply local information, ten to twelve rooms with overhead projection for contributed paper sessions and special sessions, an auditorium with twin overhead projectors for invited addresses, and registration clerks. The Society partially reimburses for the rental of facilities and equipment, and for staffing the registration desk. Most host departments volunteer; to do so, or for more information, contact the Associate Secretary for the Section.

Symposium on Some Mathematical Questions in Biology**Neural Networks**

Vancouver, Canada, August 2-3

The twenty-fourth annual Symposium on Some Mathematical Questions in Biology on *Neural networks* will be held on Thursday and Friday, August 2-3, 1990, during the Congress of the International Union for Pure and Applied Biophysics (IUPAB), July 29-August 3, 1990. The symposium is sponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics (SIAM), and the Society for Mathematical Biology (SMB).

The AMS-SIAM-SMB Committee on Mathematics in the Life Sciences serves as the Organizing Committee for the symposium. The committee consisted of Jack D. Cowan (organizer), Michael C. Mackey, Marc Mangel, Hans G. Othmer, Richard E. Plant (chairman), and John Rinzel.

The theme of the symposium is *Neural networks*. There will be two morning sessions on Thursday and Friday, August 2 and 3, each including three one-hour lectures.

For further information, contact the Symposium Conference Coordinator, AMS, P.O. Box 6248, Providence, RI 02940 or by electronic mail: BAV@MATH.AMS.COM.

See the **Funding Information** section (Landahl Travel Awards) of this issue for information on travel support from the SMB for graduate students to attend this meeting.

Program**Thursday, August 2, 9:30 a.m.**

Chairman: Robert Miura, University of British Columbia
Neurodynamics. JACK D. COWAN, University of Chicago

Learning, networks, and approximation theory. T. A. POGGIO, Massachusetts Institute of Technology

Neural networks, information theory, and perception in animals and machines. RALPH LINSKER, IBM T. J. Watson Research Center

Friday, August 3, 9:30 a.m.

Chairman: John Rinzel, National Institutes of Health

Learning and generalization in multi-layered neural networks: A statistical analysis. D. RUMELHART, Stanford University

Growing and pruning neural networks: relation to statistical mechanics. ALAN LAPEDES, Los Alamos National Laboratory

Perspectives in computational neurobiology. TERRY J. SEJNOWSKI, Salk Institute

Call For Topics For 1992 Conferences

Suggestions are invited from mathematicians, either singly or in groups, for topics of the various conferences that will be organized by the Society in 1992. The deadlines for receipt of these suggestions, as well as some relevant information about each of the conferences, are given below. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, or telephoning 401-455-4146, or sending E-mail to MEET@MATH.AMS.COM.

Individuals willing to serve as organizers should be aware that the professional meetings staff in the Society's Providence office will provide full support and assistance before, during, and after each of these conferences. Organizers should also note that for all conferences, except Summer Research Conferences, it is required that the proceedings be published by the Society, and that proceedings of Summer Research Conferences are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and the chairman of the Organizing Committee; (2) a one- to two-page description addressing the focus of the topic, including the importance and timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; and (5) a list of likely candidates who would be invited to participate and their current affiliations. Any suggestions as to sites and dates should be made as early as possible in order to allow adequate time for planning. However, proposers of conferences should know that, by action of the AMS Board of Trustees, the Meetings Department of the Society is responsible for the final selection of the site for each conference and for all negotiations with the host institution. Individuals submitting suggestions for the conferences listed below are requested to recommend sites or geographic areas which would assist the Meetings Department in their search for an appropriate site. In the case of Joint Summer Research Conferences in the Mathematical Sciences, a one-, two-, or three-week conference may be proposed.

1992 AMS Symposium in Pure Mathematics

The Symposium in Pure Mathematics has traditionally been conducted in the spring of even-numbered years in conjunction with a sectional meeting. The symposium can be held independently of a sectional meeting and serves to honor great accomplishments in mathematics. Proceedings are normally published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Topics in recent years have been:

1984—*Pseudodifferential operators and Fourier integral operators with applications to partial differential equations*, organized by FRANÇOIS TREVES of Rutgers University

1987—*The mathematical heritage of Herman Weyl*, organized by R. O. WELLS, JR. of Rice University.

1989—*Complex geometry and Lie theory*, organized by JAMES CARLSON and C. HERBERT CLEMENS, University of Utah.

Deadline For Suggestions: September 1, 1990

1992 AMS Summer Institute

Summer Institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics and usually extend over a three-week period. Dates for a Summer Institute must not overlap those of the Society's summer meeting, which at the time of this printing have not yet been determined. There should be a period of at least one week between them. Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Current and recent topics:

1988—*Operator theory/Operator algebras and applications*, organized by WILLIAM B. ARVESON of University of California, Berkeley, and RONALD G. DOUGLAS of State University of New York at Stony Brook.

1989—*Several complex variables and complex geometry*, organized by STEVEN G. KRANTZ of Washington University.

1990—*Differential geometry*, organized by ROBERT E. GREENE of University of California, Los Angeles, and SHING-TUNG YAU of Harvard University.

Deadline For Suggestions: September 1, 1990

1992 AMS-SIAM-SMB Symposium

Some Mathematical Questions in Biology

This one-day symposium, sponsored jointly by the AMS, the Society for Industrial and Applied Mathematics, and the Society for Mathematical Biology, is usually held in conjunction with the annual meeting of a biological society closely associated with the topic. Papers from the symposia are published by the AMS as volumes in the series *Lectures on Mathematics in the Life Sciences*.

Current and recent topics:

1987—*Models in population biology*, organized by ALAN HASTINGS of the University of California, Davis.

1988—*Dynamics of excitable media*, organized by HANS G. OTHMER of the University of Utah.

1989—*Sex allocation and sex change: Experiments and models*, organized by MARC MANGEL of the University of California, Davis.

1990—*Neural Networks*, organized by JACK D. COWAN of the University of Chicago.

Deadline For Suggestions: September 1, 1990

1992 AMS-SIAM Summer Seminar

The goal of the Summer Seminar, sponsored jointly by the AMS and the Society for Industrial and Applied Mathematics, is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the AMS as volumes in the series *Lectures in Applied Mathematics*.

Current and recent topics:

1987—*Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation*, organized by RANDOLPH BANK of the University of California, San Diego.

1988—*Computational solution of nonlinear systems of equations*, organized by EUGENE ALLGOWER of Colorado State University.

1989—*The mathematics of random media*, organized by WERNER KOHLER of Virginia Polytechnic Institute and BENJAMIN WHITE of Exxon Research & Engineering Company.

1990—*Vortex dynamics and vortex methods*, organized by CLAUDE GREENGARD of IBM T. J. Watson Research Center and CHRISTOPHER R. ANDERSON of University of California, Los Angeles.

Deadline For Suggestions: September 1, 1990

1992 AMS-IMS-SIAM Joint Summer Research Conferences in the Mathematical Sciences

These conferences, jointly sponsored by the AMS, the Institute for Mathematical Statistics, and the Society for Industrial and Applied Mathematics, are similar in structure to those held at Oberwolfach and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. Topics for the seventh series of one-week conferences, being held in 1990, are: *Probability models and statistical analysis for ranking data*; *Inverse scattering on the line*; *Deformation theory of algebras and quantization with applications to physics*; *Strategies for sequential search and selection in real time*; *Schottky Problems*; and *Logic, local fields, and subanalytic sets*.

If proceedings are published by the AMS, they appear as volumes in the series *Contemporary Mathematics*.

Deadline For Suggestions: February 1, 1991

Call for Topics for 1992 AMS Short Course Series

The AMS Short Courses consist of a series of introductory survey lectures and discussions which take place over a period of one-and-one-half days during the Joint Mathematics Meetings held in January and August each year. Each theme is a specific area of applied mathematics or mathematics used in the study of a specific subject or collection of problems in one of the physical, biological, or social sciences, technology, or business.

Current and recent topics:

Combinatorial games (August 1990), *Mathematical questions in robotics* (January 1990), *Cryptography and computational number theory* (August 1989), *Matrix theory and applications* (January 1989), *Chaos and fractals* (August 1988), *Computational Complexity Theory* (January 1988). Proceedings are published by the Society for Industrial and Applied Mathematics as volumes in the series *Proceedings of Symposia in Applied Mathematics*, with the approval of the Editorial Committee.

Deadline for Suggestions: Suggestions for the January 1992 course should be submitted by July 1, 1990; suggestions for the August 1992 course should be submitted by December 1, 1990.

Submit suggestions to: James W. Maxwell, AMS, P.O. Box 6248, Providence, RI 02940.

Mathematical Sciences Meetings and Conferences

1989-1990. Academic Year Devoted to Hyperbolic Geometry and Quasiconformal Mappings, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1988, p. 1584)

1989-1990. Special Year in Geometry, University of Maryland, College Park, MD. (Dec. 1989, p. 1432)

Spring Term 1990. Aldo Andreotti Special Semester in Pisa, Pisa, Italy. (Mar. 1990, p. 324)

1990. IMACS International Workshop on Massively Parallel Methods in Computational Physics, Boulder, Colorado. (Sep. 1989, p. 914)

1990. IMACS Conference on Computer Aided Design, Yugoslavia. (Sep. 1989, p. 914)

1990. CWI-IMACS Symposia on Parallel Scientific Computing, Amsterdam, The Netherlands. (Feb. 1990, p. 216)

1990. Concentration Year on Stochastic Models, Statistical Methods, and Algorithms in Image Analysis, Rome, Italy.

PURPOSE: The aims of this year of study are: 1). To enhance the interaction and collaboration between mathematicians and scientists from other disciplines (in particular: biology, physics, engineering, and medicine); 2). To stimulate the formalization and study of mathematical problems suggested from the applied sciences; 3). To facilitate the collaboration between mathematicians coming from different backgrounds and researchers from industry or other productive activities in projects of common applied interest.

ORGANIZERS: P. Baldi, D. Geman, U. Grenander, M. Piccioni, E. Presutti, B. Ripley, Y. Vardi.

INVITED SPEAKERS: Y. Amit, R.G. Azencott, M. Barnsley, O. Catoni, T.S. Chiang, Y. Chow, P. Clifford, F. Comets, B. Derrida, P. Diaconis, D.J. Geman, S. Geman, B. Gidas, F. Godlieb, C. Graffigne, P.J. Greene, U. Grenander, X. Guyon, B. Hajek, R. Holley, C.R. Hwang, N. Karssemeijer, R.L. Kashyap, J. Kay, J.T. Kent, D. Lee, T.M. Liggett, S.K. Mitter, R. Molina, B.D. Ripley, R. Schonman, L.A. Shepp, A.D. Sokal, H. Spohn, D. Tjostheim, A. Trounev, Y. Vardi, G. Wahba, A.S. Willsky, L. Younes.

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

EFFECTIVE with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.

INFORMATION: Secretariat: G. Castellini or G. Silveri, IAC, Viale del Policlinico 137, I-00161 Roma (ph. (39 6) 88470-213 or 214 and Fax n. (39 6) 88470228).

1990-1991. Academic Year Devoted to Operator Theory and Complex Analysis, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1989, p. 1432)

April 1990

29-May 5. Gruppentheorie (Pro-Endliche Gruppen), Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

30-May 4. Mathématiques pour la Robotique, Marseille, France. (Jan. 1990, p. 54)

May 1990

3-4. Twenty-first Annual Pittsburgh Conference on Modeling and Simulation, Uni-

versity of Pittsburgh, Pittsburgh, PA. (Sep. 1989, p. 916)

3-4. **Automation and Information Engineering Annual Research Review Conference**, College Park, MD. (Mar. 1990, p. 326)

4. **Second Conference on Mathematical Biology**, Stony Brook, NY. (Mar. 1990, p. 326)

5-6. **Pacific Northwest Geometry Seminar**, University of Oregon, Eugene, OR. (Jan. 1990, p. 55)

5-6. **Midwest Partial Differential Equations Seminar**, Northwestern Univ., Evanston, IL. (Mar. 1990, p. 326)

6-9. **Computer Algebra and Differential Equations (CADE-90)**, Cornell University, Ithaca, NY. (Feb. 1990, p. 218)

6-12. **Geschichte der Mathematik**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 766)

7-9. **1990 IEEE Symposium on Research in Security and Privacy**, Oakland, CA. (Oct. 1989, p. 1095)

7-9. **Geometric Modeling and Design**, Wayne State Univ., Detroit, MI. (Mar. 1990, p. 326)

7-10. **SIAM Conference on Applications of Dynamical Systems**, Orlando, FL. (Sep. 1989, p. 916)

7-11. **Recent Advances in Regression**, Montréal, Canada. (Jan. 1990, p. 55)

7-11. **Algorithmes et Programmation**, Marseille, France. (Jan. 1990, p. 55)

7-11. **Statistics Week**, Université de Montréal, Canada. (Feb. 1990, p. 218)

7-June 1. **College on Recent Developments and Applications in Mathematics and Computer Science**, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 601)

* 9-11. **Applications of Mathematical/Statistical Libraries and Problem-Solving Systems**, Monterey, CA.

INFORMATION: D. Mar, IMSL User Group North America, Naval Postgraduate School, 1332 Lincoln Avenue, Pacific Grove, CA 93950; 408-646-2672.

9-12. **Computer Algebra and Parallelism (CAP-90)**, Cornell University, Ithaca, NY. (Feb. 1990, p. 218)

13-19. **Abstrakte Konvexe Analysis**, Oberwolfach, Federal Republic of Ger-

many. (Jul./Aug. 1989, p. 766)

14-15. **Finite Element Applications in Computational Mechanics**, Champaign, IL. (Mar. 1990, p. 326)

14-15. **Regional Workshop on Nonlinear Conservation Laws**, Stony Brook, NY. (Jan. 1990, p. 55)

14-18. **Conference on Nonlinear Analysis and Partial Differential Equations**, Rutgers University, New Brunswick, NJ. (Mar. 1990, p. 326)

14-18. **Workshop on K-Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 55)

14-18. **Singularities et Theorie de Hodge**, Marseille, France. (Jan. 1990, p. 55)

14-18. **Surfaces, Submanifolds, and their Applications**, Univ. of Leeds, Leeds, England. (Mar. 1990, p. 326)

17-19. **Interface '90 (formerly Computer Science and Statistics: Symposium on Interface)**, East Lansing, MI. (Sep. 1989, p. 916)

17-19. **Colloquium: Computer Graphics in Pure Mathematics**, University of Iowa, Iowa City, IA. (Dec. 1989, p. 1435)

18-20. **Nineteenth Annual State of Jefferson Mathematics Congress**, Whiskeytown, CA. (Feb. 1990, p. 219)

20-23. **1990 International Industrial Engineering Conference**, San Francisco, CA. (Mar. 1990, p. 327)

20-25. **NSF/CBMS Conference on Operator Algebras**, Texas Christian University, Fort Worth, TX. (Jan. 1990, p. 55)

20-26. **The Schrödinger Equation and Its Classical Counterparts**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

21-24. **The Simulation of Random Processes and Fields - Mathematics and Applications**, Portofino, Italy. (Sep. 1989, p. 916)

21-25. **NSF-CBMS Regional Conference on The Interface between Analytic Number Theory and Harmonic Analysis**, Manhattan, KS. (Jan. 1990, p. 55)

21-25. **Eleventh United States National Congress of Applied Mechanics**, Tucson, AZ. (Nov. 1988, p. 1389)

21-25. **Nonlinear Analysis, Function Spaces and Applications IV**, Czechoslovakia. (Jan. 1990, p. 56)

21-25. **DIMACS Workshop: Algebraic Issues in Geometric Computations**, New Brunswick, NJ. (Mar. 1990, p. 327)

* 21-25. **Domain Decomposition Methods for Partial Differential Equations**, Moscow, USSR.

PROGRAM: This is the fourth international symposium on domain decomposition methods for PDE's. The program will focus almost exclusively on domain decomposition methods, but talks on multigrid methods might also be scheduled. Thirteen main speakers have been invited. There will also be a number of shorter contributed talks. All papers will be published in Russian by the USSR Academy and in English by SIAM.

INFORMATION: O. Widlund, Program Committee, c/o Courant Institute of Mathematical Sciences, 251 Mercer St., Room 530, New York, NY 10012. (212)998-3310.

* 22-24. **Third International Symposium of Numerical Analysis**, Madrid, Spain.

INVITED SPEAKERS: Professors Samarski, Tihomirov, and Mihailov (USSR); Douglas (USA); Ortiz (Great Britain); Ansgore, Niethammer, and Werner (Germany); Ciarlet, Pironneau, and Raviart (France); Axelsson (The Netherlands); and others.

INFORMATION: I.S.N.A. 3, C. Vega Univ. Politécnica de Madrid, Ramiro de Maeztu, s/n, 28040 Madrid, Spain.

* 22-25. **Computer Simulations Statistical Methods and Applications**, Portofino, Italy.

INFORMATION: F. Marchetti, Univ. di Genova, Dipartimento di Matematica, v L.B. Alberti 4, I-16132 Genova, Italy; (+39-10)353-8717.

23-25. **1990 International Symposium on Multiple-Valued Logic**, Charlotte, NC. (Apr. 1989, p. 496)

23-25. **Workshop on Viscous and Numerical Approximation of Shock Waves**, North Carolina State University, Raleigh, NC. (Feb. 1990, p. 219)

23-27. **Azumaya Algebras, Group Actions, and Modules: A Conference in Honor of Goro Azumaya's 70th Birthday**, Indiana University, Bloomington, IN. (Feb. 1990, p. 219)

24. **Second Conference on Lagrangian Calculus**, Community College of Philadelphia, Philadelphia, PA. (Feb. 1990, p. 219)

24-25. **Twelfth Symposium on Math-**

Mathematical Programming with Data Perturbations, George Washington Univ., Washington, DC. (Nov. 1989, p. 1250)

24-26. Conference on Probability Models in Mathematical Physics, Colorado Springs, CO. (Jan. 1990, p. 56)

25-31. Tenth International Conference on Pattern Recognition, Resorts Hotel, Atlantic City, NJ. (Mar. 1988, p. 466)

27-June 2. Lyapunov-Exponents, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

28-June 1. Twenty-second Annual Conference on Statistics, Tours, France. (Jan. 1990, p. 56)

28-June 1. Tenth International Conference on Distributed Computing Systems, Paris, France. (Jan. 1990, p. 56)

28-June 1. Mecanique Celeste et Systemes Hamiltoniens, Marseille, France. (Jan. 1990, p. 56)

28-June 1. Workshop on Set Theoretic Methods in Algebra, Baylor University, Waco, Texas. (Feb. 1990, p. 219)

28-June 2. Geometry of Complex Projective Varieties, Cetraro, Italy. (Nov. 1989, p. 1250)

29-30. Algebraic Logic Conference in Honour of Professor Don Monk, Boulder, Colorado. (Nov. 1989, p. 1250)

29-31. GAMM/IFIP Workshop: "Stochastic Optimization: Numerical Methods and Technical Applications", Neuberg, Federal Republic of Germany. (Jan. 1990, p. 56)

29-June 1. Eleventh Annual Conference of the Canadian Applied Mathematics Society, Halifax, Nova Scotia. (Oct. 1989, p. 1096)

29-June 2. Dynamical Theories of Turbulence in Fluid Flows, Minneapolis, MN. (Nov. 1989, p. 1250)

29-June 2. Workshop on Dynamical Systems in Fluid Mechanics, Minneapolis, MN. (Nov. 1989, p. 1251)

30-31. Conference on Algebraic Logic, Boulder, Colorado. (Dec. 1989, p. 1436)

31-June 1. Annual Meeting of the Canadian Society for History and Philosophy of Mathematics, University of Victoria, British Columbia. (Feb. 1990, p. 220)

31-June 2. Seventh Annual Western Geometric Topology Workshop, Oregon State University.

SPONSOR: National Science Foundation and Oregon State Univ.

ORGANIZING COMMITTEE: D. Garity, Oregon State Univ.; D. Wright, Brigham Young Univ.; J. Henderson and F. Tinsley, Colorado College.

PRINCIPLE SPEAKER: R. Daverman, Univ. of Tennessee.

INFORMATION: D. Garity, Dept. of Math., St. Cloud State Univ., St. Cloud, MN 56301.

31-June 3. Percolation Models of Material Failure, Cornell University, Ithaca, NY. (Dec. 1989, p. 1436)

June 1990

June-July 1990. International IMACS Conference on Mathematical Modelling and Applied Mathematics, Vilnius, USSR. (Sep. 1989, p. 917)

1-8. Third International Symposium on Orthogonal Polynomials and Their Applications, Erice-Trapani (Sicily), Italy. (Dec. 1989, p. 1436)

1-10. Fourth Annual Meeting of the International Workshop in Analysis and its Applications, Dubrovnik-Kupari, Yugoslavia. (Oct. 1989, p. 1096)

3-6. 1990 Annual Meeting of the Statistical Society of Canada, St. John's, Newfoundland, Canada. (Sep. 1989, p. 917)

3-6. Symposium on Chaos in Biological and Agricultural Systems, Lincoln, Nebraska. (Jan. 1990, p. 56)

3-9. Graphentheorie, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

4-7. Fifth Annual IEEE Symposium on Logic in Computer Science, Philadelphia, PA. (Sep. 1989, p. 917)

4-8. Workshop on Model Theory, Berkeley, CA. (Sep. 1989, p. 917)

4-8. Nonlinear Phenomena in Atmospheric and Oceanic Sciences, Minneapolis, MN. (Nov. 1989, p. 1251)

4-8. International Conference on Approximation Interpolation and Summability in Honor of A. Jakimovski, Tel Aviv, Israel. (Dec. 1989, p. 1436)

4-8. International Conference on Bootstrapping and Related Techniques, Trier, Federal Republic of Germany. (Jan. 1990, p. 56)

4-8. The Mathematics of Neural Nets, Salisbury State Univ., Salisbury, MD.

4-12. Recent Developments in Geometric Topology and Related Topics, Villa "La Querceta", Montecatini Terme. (Feb. 1990, p. 220)

4-15. Analyse Harmonique sur Les Groupes Reductifs P-Adiques, Marseille, France. (Jan. 1990, p. 56)

4-28. Supercomputing Program for Undergraduate Research, Cornell National Supercomputing Facility, Ithaca, NY. (Feb. 1990, p. 220)

6-8. First IFIP Conference on Fractals, Lisbon, Portugal. (Jan. 1990, p. 57)

6-9. Fifth Annual Conference of the European Consortium for Mathematics in Industry, Lahti, Finland. (Apr. 1989, p. 496)

6-12. 1990 Barcelona Conference on Algebraic Topology, Centre de Recerca Matematica, Barcelona, Spain. (Sept. 1988, p. 1060)

6-15. Third Logical Biennial (in honour of S.C. Kleene), Chaika (near Varna), Bulgaria. (Oct. 1989, p. 1096)

7-July 4. 1990 Joint Summer Research Conferences in the Mathematical Sciences, University of Massachusetts at Amherst, MA.

INFORMATION: C. Kohanski, AMS, P.O. Box 6248, Providence, RI 02940.

10-14. Sixth Haifa Matrix Conference Technion City, Haifa, Israel. (Feb. 1990, p. 220)

10-16. Reelle Algebraische Geometrie, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

10-16. Fourth Czechoslovak Symposium on Combinatorics, Prachtice, Czechoslovakia. (Nov. 1989, p. 1251)

*10-16. International Workshop on Algorithms and Parallel VLSI Architectures, Pont-à-Mousson, France.

INFORMATION: A.-J. van der Veen, Dept. of Electrical Engineering, Delft Univ. of Technology, 2628 CD Delft, The Netherlands; +3115781442.

11-14. Fourteenth Rolf Nevanlinna Colloquium, University of Helsinki, Helsinki, Finland. (Jul./Aug. 1989, p. 767)

11-14. Fifth SIAM Conference on Discrete Mathematics, Atlanta, GA. (Sep. 1989, p. 917)

11-15. World Organization of Systems and Cybernetics Eighth International Congress, New York, NY. (Please note date

change from Mar. 1989, p. 315)

11-15. **Chaotic Processes in the Geological Sciences**, Minneapolis, MN. (Nov. 1989, p. 1251)

11-15. **Third International Conference on Hyperbolic Problems**, Uppsala, Sweden. (Jan. 1990, p. 57)

11-15. **Rigorous Results in Quantum Dynamics**, Liblice Castle, Czechoslovakia. (May/Jun. 1989, p. 602)

11-15. **NSF/CBMS Conference on Wavelets**, University of Lowell, Lowell, MA. (Nov. 1989, p. 1251)

11-15. **IMACS First International Conference on Computational Physics**, Boulder, CO. (Jan. 1990, p. 57)

11-15. **The Mathematics of Computer Graphics**, Salisbury State Univ., Salisbury, MD. (Mar. 1990, p. 328)

11-15. **Undergraduate Faculty Enhancement "Workshop on Computational Number Theory"**, Univ. of Wisconsin-Whitewater, WI. (Mar. 1990, p. 328)

12-15. **Ninth International Conference on Analysis and Optimization of Systems**, Antibes, France. (Jan. 1990, p. 57)

12-15. **Workshop on Spectral and Scattering Theory of Partial Differential Operators**, Institute of Mathematics, Hebrew Univ., Jerusalem, Israel. (Feb. 1990, p. 220)

13-15. **Seventh Annual Quality and Productivity Research Conference**, Madison, WI. (Mar. 1989, p. 315)

13-16. **Function Estimation and Statistical Applications**, Cornell University, Ithaca, NY. (Feb. 1990, p. 221)

13-22. **Free Boundary Problems: Theory and Applications**, Centre de Recherches Mathématiques, Université de Montréal, Canada. (Jul./Aug. 1989, p. 767)

14-16. **Sixth Summer Conference on General Topology and Applications**, Long Island Univ. (C.W. Post Campus), Brookville, NY. (Feb. 1990, p. 221)

14-16. **Fifth Southeast Asian Conference on Mathematical Education (SEACME 5)**, Gadong, Brunei Darussalam. (Nov. 1989, p. 1251)

14-16. **Function Estimation and Statistical Applications**, Cornell Univ., Ithaca, NY. (Mar. 1990, p. 328)

15-20. **Global Differential Geometry and Global Analysis**, Berlin, Federal Republic of Germany. (Jan. 1990, p. 57)

17-23. **Partial Differential Equations in**

Complex Analysis, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

18-20. **Joint WNAR-IMS Regional Meeting**, Montana State University, Bozeman, MT. (Mar. 1989, p. 315)

18-21. **A Conference on Partial Differential Equations, in Honor of Shmuel Agmon**, Inst. of Math., Hebrew Univ., Jerusalem, Israel. (Feb. 1990, p. 221)

18-22. **Fourteenth Mathematical Sciences Lecture Series on Partially Ordered Sets**, Johns Hopkins University, Baltimore, Maryland. (Oct. 1989, p. 1096)

18-22. **Approximations Diophantiennes et Nombres Transcendants**, Marseille, France. (Jan. 1990, p. 57)

18-23. **The Fifth International Conference on Topology and its Applications**, Dubrovnik, Yugoslavia. (Mar. 1990, p. 329)

18-26. **Recent Developments in H_∞ Control Theory**, Villa Olmo, Como. (Feb. 1990, p. 221)

18-29. **Radar/Sonar**, Minneapolis, MN. (Nov. 1989, p. 1251)

18-29. **AMS-SIAM Summer Seminar on Vortex Dynamics and Vortex Methods**, University of Washington, Seattle, WA.

INFORMATION: B. Verducci, AMS, P.O. Box 6248, Providence, RI 02940.

20-22. **Sixteenth International Workshop on Graph-Theoretic Concepts in Computer Science**, Berlin, Federal Republic of Germany. (Jan. 1990, p. 57)

20-23. **Second Symposium on Chaotic Dynamical Systems**, Conference Center "Woudschoten" (near Utrecht), The Netherlands. (Mar. 1990, p. 329)

* 21-27. **Curves and Surfaces**, Chamonix-Mont Blanc, France.

INFORMATION: C. Rivet, Curves and Surfaces TIM3-IMAG, Univ. Joseph Fourier BP 53X, 38041, Grenoble Cedex, France.

* 24-28. **NSF/CBMS Regional Conference on Ergodic Theory and Combinatorial Number Theory**, North Dakota State Univ., Fargo, ND.

PROGRAM: H. Fürstenberg will deliver ten lectures on the recent developments in topics related to the conference title.

ORGANIZER: D. Comez.

INFORMATION: D. Comez, Dept. of

Math., North Dakota State Univ., Station, P.O. Box 5075, Fargo, ND 58105; 701-237-7490; nmcomez@plains.nodak.edu.

24-30. **Mathematische Probleme in der Nichtlinearen Elastizität**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

25-29. **International Symposium on Fuzzy Approach to Reasoning and Decision Making**, Bochyne, Czechoslovakia. (Oct. 1989, p. 1096)

25-29. **Logique et Informatique**, Marseille, France. (Feb. 1990, p. 221)

25-July 13. **SMS-NATO ASI: Shape Optimization and Free Boundaries**, Université de Montréal, Montréal, Canada. (Dec. 1989, p. 1437)

27-29. **ACM Conference on Lisp and Functional Programming**, Nice, France. (Jan. 1990, p. 58)

27-30. **Fourth International Congress on Algebraic Hyperstructures and Applications**, Xanthi, Greece. (Apr. 1990, p. 496)

July 1990

July 1990. **AMS Summer Research Institute on Differential Geometry**, University of California, Los Angeles, CA.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

1-7. **Modulfunktionen In Mehreren Variablen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

1-15. **International Symposium on Algebraic Topology - Adams Memorial Symposium**, University of Manchester, England. (Sep. 1989, p. 918)

1-18. **Twentieth Summer Session on Probability Theory**, Saint-Flour (Cantal), France. (Mar. 1989, p. 315)

2-6. **Tenth Australian Statistical Conference/Second Pacific Statistical Congress**, Sydney, Australia. (Jul./Aug. 1989, p. 768)

2-6. **The Jónsson Symposium**, Laugvatn, Iceland. (Sep. 1989, p. 918)

2-6. **Thirty-fourth Annual Meeting of the Australian Mathematical Society**, Townsville, Queensland, Australia. (Oct. 1989, p. 1097)

2-6. **Fifteenth International Biometrical**

Conference, Budapest, Hungary. (Jan. 1990, p. 58)

2-7. **Groupes Ordonnés et Groupes de Permutation**, Marseille, France. (Jan. 1990, p. 58)

2-10. **Continua with Microstructures**, Villa "La Querceta", Montecatini Terme. (Feb. 1990, p. 222)

2-31. **Time Series**, Minneapolis, MN. (Nov. 1989, p. 1252)

2-August 10. **Représentations des Groupes et des Algèbres de Lie**, Université de Montréal, Canada. (Feb. 1990, p. 222)

2-6. **Eleventh Dundee Conference on Ordinary and Partial Differential Equations**, Dundee, Scotland. (Sep. 1989, p. 918)

2-7. **Lattice Path Combinatorics and Applications**, McMaster University, Hamilton, Ontario, Canada. (Feb. 1990, p. 222)

2-7. **International Colloquium on Applications of Mathematics (on the occasion of the 80th birthday of Lothar Collatz)**, Hamburg, West Germany. (Feb. 1990, p. 222)

2-14. **Variationsrechnung**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

2-11. **"Università di Genova - The Ohio State University Joint Conference" on New Trends in Systems Theory**, Genoa, Italy. (Jul./Aug. 1989, p. 768)

2-14. **4ème Colloque International de Théorie des Graphes et de Combinatoire**, Marseille-Luminy, C.I.R.M., France. (Jan. 1990, p. 58)

2-20. **Geometry and Topology of Four-Manifolds**, McMaster University, Hamilton, Ontario, Canada. (May/Jun. 1989, p. 602)

2-20. **SIAM Annual Meeting**, Chicago, IL. (Mar. 1990, p. 329)

2-21. **Stochastic Image Models and Algorithms**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

2-22. **1990 European Summer Meeting (Logic Colloquium '90)**, University of Helsinki, Finland. (Feb. 1990, p. 222)

2-23. **Colloquium in Honor of Roland Fraisse**, Centre International de Recherches Mathématiques, Luminy, France. (May/Jun. 1989, p. 602)

2-20. **SIAM Annual Meeting**, Chicago, IL. (Nov. 1988, p. 1389)

2-20. **Symposium Fraisse**, Marseille, France. (Jan. 1990, p. 58)

16-20. **NSF-CBMS Regional Conference "The Polynomial Identities and Invariants of $n \times m$ Matrices"**, DePaul Univ., Chicago, IL. (Mar. 1990, p. 330)

16-21. **Design and Analysis of Scientific Experiments**, Cambridge, MA. (Mar. 1990, p. 330)

16-27. **Regional Institute in Dynamical Systems**, Boston Univ., Boston, MA. (Mar. 1990, p. 330)

* 16-August 3. **Conference on "Enriching Discrete Mathematics Courses with Recent Developments"**, Univ. of Wyoming, Laramie, WY.

PROGRAM: Mornings will be devoted to lectures by the speakers which will address selected important and recent developments in discrete mathematics. Afternoons will be devoted to discussions, work sessions and/or talks which will assist in the incorporation of these ideas and concepts into college courses at all levels. Funds to cover living costs and a small stipend are available.

INVITED SPEAKERS: The main speaker will be William F. Lucas, The Claremont Graduate School, who will lecture each day for the three week period. Carl W. Lee, The University of Kentucky, will lecture for at least two weeks.

INFORMATION: A.D. Porter, Mathematics Department, P.O. Box 3036 University Station, University of Wyoming, Laramie, WY 82071-3036.

22-28. **Konvexgeometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

23-27. **CADE 10 - Tenth International Conference on Automated Deduction**, West Germany. (Feb. 1990, p. 223)

23-28. **Fourth International Congress on Computational and Applied Mathematics**, Leuven, Belgium. (Jan. 1990, p. 58)

23-August 4. **Third Workshop on Stochastic Analysis**, Silivri, Istanbul-Turkey. (Feb. 1990, p. 223)

26-29. **International Conference on New Trends in Geometric Function Theory and Applications**, University of Madras, Madras, India. (Sep. 1989, p. 918)

29-August 4. **Mechanik Und Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

30-August 4. **The Fourth International Conference on Fibonacci Numbers and**

their Applications, Wake Forest University, Winston Salem, NC. (Nov. 1989, p. 1252)

31-August 2. **Dynamics of Numerics and the Numerics of Dynamics**, Bristol, England. (Nov. 1989, p. 1252)

August 1990

2-3. **AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology, Neural Networks**, Vancouver, Canada. (Mar. 1990, p. 330)

5-9. **From Topology to Computation: Unity and Diversity in the Mathematical Sciences (in Honor of Professor Stephen Smale's 60th Birthday)**, Berkeley, CA. (Jan. 1990, p. 58)

5-11. **Mathematical Methods in Tomography**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

5-11. **International Conference on Approximation Theory**, Hungary. (Oct. 1989, p. 1097)

6-7. **AMS Short Course on Combinatorial Games**, Columbus, Ohio.

INFORMATION: M. Foulkes, AMS, P.O. Box 6248, Providence, RI 02940.

6-9. **1990 Joint Statistical Meetings**, Anaheim, CA. (Mar. 1988, p. 466)

6-10. **Singularities**, Honolulu, Hawaii. (Feb. 1990, p. 223)

8-11. **Joint Mathematics Meetings**, Ohio State University, Columbus, OH. (including the summer meetings of the AMS, AWM, MAA and PME). This is the 75th Anniversary of the MAA.

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

8-11. **The Fifth KIT Mathematics Workshop**, Korea Institute of Technology, Taejeon, Korea. (Mar. 1990, p. 330)

* 11-14. **Crypto '90**, University of California, Santa Barbara, CA.

SPONSORS: International Association for Cryptological Research; Univ. of California, Santa Barbara Computer Security Dept.; IEEE Computer Society Technical Committee on Security and Privacy.

CALL FOR PAPERS: Papers are solicited on all topics related to current work in the theory and application of cryptographic techniques. Authors are requested to submit 12 copies of

an extended abstract or full paper by April 16, 1990, sent to: S.A. Vanstone, Program Chair, Dept. of Combinatorics and Optimization, Univ. of Waterloo, Waterloo, Ontario, Canada N2L 3G1.

INFORMATION: S.S. McMahan, General Chair, Cylink, 110 S. Wolfe Rd., Sunnyvale, CA 94086.

12-13. **Workshop on Using Technology to Enhance the Teaching and Learning of Calculus and Precalculus Mathematics**, The Ohio State Univ., Columbus, OH. (Mar. 1990, p. 330)

12-18. **Algebraische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

12-18. **Pre-Congress Topology Conference**, University of Hawaii, Honolulu, HI. (Feb. 1990, p. 223)

13-16. **Alaska Conference, Quo Vadis, Graph Theory?**, University of Alaska, Fairbanks, AK. (Oct. 1989, p. 1097)

13-17. **Fifth International Conference on Hadronic Mechanics and Nonpotential Interactions**, University of Northern Iowa, Cedar Falls, Iowa. (Jul./Aug. 1989, p. 768)

13-17. **Eleventh IFAC World Congress**, Tallin, USSR. (Sep. 1989, p. 918)

13-17. **Algebraic Geometry and Analytic Geometry**, Tokyo, Japan. (Sep. 1989, p. 919)

13-17. **1990 International Conference on Parallel Processing**, Pennsylvania State University, University Park, PA. (Dec. 1989, p. 1438)

13-17. **NSF/CBMS Conference on Random Number Generation and Quasi-Monte Carlo Methods**, Univ. of Alaska, Fairbanks, AK. (Mar. 1990, p. 331)

13-18. **Institute of Mathematical Statistics Fifty-third Annual Meeting (jointly with the Second World Congress of the Bernoulli Society)**, Uppsala, Sweden. (Sep. 1989, p. 919)

13-18. **Tsukuba International Conference on Representations of Algebras and Related Topics**, University of Tsukuba, Japan. (Nov. 1989, p. 1253)

14-18. **The Asian Mathematical Conference 1990**, Hong Kong, China. (Sep. 1989, p. 919)

14-18. **Harmonic Analysis, Sendai 1990**, Tohoku University, Sendai, Japan. (Feb. 1990, p. 223)

14-18. **Zeta Functions in Geometry**, Tokyo Institute of Technology, Tokyo, Japan. (Feb. 1990, p. 223)

15-19. **International Conference on Knot Theory and Related Topics**, International House, Osaka, Japan. (Apr. 1989, p. 497)

15-19. **International Conference on Commutative Algebra and Combinatorics**, Nagoya University, Nagoya, Japan. (Feb. 1990, p. 224)

15-20. **Conference on Gaussian Random Fields (The Third Nagoya Lévy Seminar)**, Nagoya University, Nagoya, Japan. (Nov. 1989, p. 1253)

16-18. **SIGAL International Symposium on Algorithms**, Tokyo, Japan. (Oct. 1989, p. 1097)

16-19. **Current Topics in Operator Algebras**, Nara Ken-New Public Hall, Nara, Japan. (Feb. 1990, p. 224)

18-22. **The Second International Conference on Graph Theory**, Kanagawa, Japan. (Feb. 1990, p. 224)

19-20. **Inverse Problems in Engineering Sciences**, Osaka Institute of Technology, Osaka, Japan. (Feb. 1990, p. 224)

19-25. **Mathematische Methoden Des VLSI-Entwurfs Und Des Distributed Computings**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

20-24. **Second International Joint Conference of the ISSAC-90 and the AAEECC-8**, Nihon University, Tokyo, Japan. (Feb. 1990, p. 224)

*20-24. **International Conference on Combinatorics (ICC '90)**, Hefei, Anhui, China.

PROGRAM: The technical program will include a variety of scheduled and submitted talks related to the general themes of the conference. The language of the conference will be English. The conference will provide a timely opportunity for researchers and students to exchange ideas in formal and informal dialogue. It is hoped that ICC '90 can serve as a focus for ongoing research in these areas as well as for modern applications in other disciplines.

INFORMATION: K. Tung-Hsin, Hefei Branch of Academia Sinica, P.O. Box 10, Hefei, Anhui, 230031, China (PRC).

20-25. **Fifth Conference on Numerical Methods**, Miskolc, Hungary. (Jan. 1990, p. 59)

21-29. **The International Congress of Mathematicians 1990**, Kyoto, Japan. (Nov. 1988, p. 1389)

23-September 1. **Twenty-eighth International Symposium on Functional Equations**, Graz-Mariatrost, Austria. (Dec. 1989, p. 1438)

26-September 1. **Komplexe Analysis**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

27-31. **Eleventh Prague Conference on Information Theory, Statistical Functions and Random Processes**, Praha, Czechoslovakia. (Jan. 1990, p. 59)

28-30. **IMACS European Simulation Meeting on Problem Solving by Simulation**, Esztergom, Hungary. (Mar. 1989, p. 316)

28-31. **Operations Research 1990, International Conference Operations Research**, Vienna, Austria. (Jul./Aug. 1989, p. 768)

29-31. **International Colloquium on Words, Languages, and Combinatorics**, Kyoto Sangyo University, Kyoto, Japan. (Feb. 1990, p. 224)

30-September 1. **International Symposium on the Semigroup Theory and its Related Fields**, Ritsumeikan University, Kyoto, Japan. (Feb. 1990, p. 224)

30-September 2. **International Symposium on Functional Differential Equations and Related Topics**, Kyoto Sangaku Kaikan (YOUANDI), Kyoto, Japan. (Feb. 1990, p. 224)

30-September 4. **International Conference on Potential Theory**, Nagoya, Japan. (May/Jun. 1989, p. 602)

30-September 4. **International Symposium on Computational Mathematics**, Matsuyama, Japan. (Feb. 1990, p. 224)

31-September 1. **Tokyo History of Mathematics Symposium 1990**, University of Tokyo, Tokyo, Japan. (Feb. 1990, p. 224)

31-September 2. **Conference on Representation Theories of Lie Groups and Algebras**, Lake-Kawaguchi, Yamanshi, Japan. (Feb. 1990, p. 224)

31-September 4. **International Symposium on Functional Analysis and Related Topics**, Sapporo, Japan. (Feb. 1990, p. 225)

31-September 4. **General Topology and Geometric Topology Symposium**, University of Tsukuba, Japan. (Feb. 1990, p. 225)

September 1990

- September/October 1990. IMACS-GAMM Conference on Computer Arithmetic, Scientific Computation and Mathematical Modelling, Bulgaria. (Sep. 1989, p. 919)
- IMACS Symposium on Modelling and Simulation of Electrical Machines, ENSEM - Nancy, France. (May/Jun. 1989, p. 602)
- 2-7. Twelfth International Conference on Nonlinear Oscillations, Cracow, Poland. (Sep. 1989, p. 919)
- 2-7. International Conference on Integral Equations and Boundary Value Problems, Yantai University, Shandong, People's Republic of China. (Nov. 1989, p. 1253)
- 2-8. Topologie, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)
- 3-6. Fourth Asian Logic Conference, Tokyo, Japan. (Mar. 1989, p. 316)
- 3-7. IMACS Symposium on Intelligent Models in Systems Simulation, Brussels, Belgium. (Mar. 1989, p. 316)
- 3-7. Representation des Groupes et Analyse Complexe, Marseille, France. (Jul./Aug. 1989, p. 768)
- 3-7. International Conference on Dynamical Systems and Related Topics, Nagoya University, Nagoya, Japan. (Feb. 1990, p. 225)
- 3-8. Physical Interpretations of Relativity Theory, Imperial College, London, England. (Mar. 1990, p. 331)
- 8-12. Neuronet-90: IMACS International Symposium on Neural Nets and Neural Computers, Prague, Czechoslovakia. (Please note change from May/Jun. 1989, p. 602)
- 9-15. Surgery and L-Theory, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)
- 10-12. Second International Workshop on Advances in Robot Kinematics, Linz, Austria. (Mar. 1990, p. 332)
- 10-14. Mathematiker-Kongress, Dresden, German Democratic Republic. (Jul./Aug. 1989, p. 769)
- 10-14. Greco Calcul Formel, Marseille, France. (Jan. 1990, p. 60)
- 10-14. Real Analysis and Measure Theory, Capri, Italy. (Mar. 1990, p. 332)
- 10-October 5. School on Qualitative Aspects and Applications of Nonlinear Evolution Equations, International Centre

for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 602)

16-22. Risikotheorie, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

17-21. Atelier International de Theorie des Ensembles, Marseille, France. (Jan. 1990, p. 60)

17-22. DMV-Jahrestagung 1990, Bremen, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

* 21-27. International Functional Analysis Meeting on the Occasion of the Sixtieth Birthday of Professor M. Valdivia, Peñíscola (Castellón), Spain.

SPONSORS: Univ. of Valencia and Polytechnical Univ. of Valencia.

ORGANIZING COMMITTEE: K.D. Bierstedt, Univ. Paderborn, W. Germany; J. Bonet, Univ. Politénica de Valencia; J. Horváth, Univ. of Maryland; M. Maestre, Univ. de Valencia.

CONFERENCE TOPICS: Topics expected to be emphasized include locally convex spaces, Fréchet spaces, Banach space theory, function spaces, holomorphy, topological tensor products and operator ideals.

INVITED SPEAKERS: Altomare, Ansemil, Aron, Bessaga, Bombal, Cobos, A. Defant, S. Dierolf, Diestel, Dineen, Florencio, Floret, Godefroy, Isidro, Jarchow, H. König, Llavona, Laursen, Meise, Moscatelli, Mujica, Nachbin, Orihuela, Pelczyński, Pietsch, Pisier, Schachermayer, Schmets, Taskinen, D. Vogt.

CALL FOR PAPERS: There will be a limited number of short communications (of 15 minutes). Interested contributors are invited to submit an abstract (to J. Bonet) as soon as possible. The abstracts will be refereed. It is planned to publish the Proceedings of the Conference.

INFORMATION: J. Bonet, Dept. of Matemática Aplicada, E.T.S. Arquitectura, Univ. Politénica de Valencia, C. de Vera, E-46071 Valencia, Spain; 346-3615051 ext. 408 or 402; email: maestre@evalun11.bitnet.

23-29. Random Graphs and Combinatorial Structures, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

24-28. Structure Galoisienne Arithmetique, Marseille, France. (Jan. 1990, p. 60)

24-28. IMACS-GAMM International

Symposium on Computer Arithmetic, Scientific Computation and Mathematical Modelling - SCAN 1990, Albena (near Varna), Bulgaria. (Feb. 1990, p. 225)

24-29. Mathematical Modelling of Industrial Processes, Tecnopolis, Bari. (Feb. 1990, p. 225)

* 24-30. Ibero-American Conference, Seville, Spain.

INFORMATION: U. D'Ambrosio, Institute of Math, Univ. Estadual de Campinas, CP 6063 (13081) Campinas (SP), Brazil.

* 25-29. International Symposium on Structures in Mathematical Theories, San Sebastián, Spain. (Please note changes from Jan. 1990, p. 60)

INVITED SPEAKERS: A. Arhangel'skii, Moscow; A. Barabashev, Moscow; E. Bencivenga, Irvine; R. Bkouche, Lille; H. Breger, Hannover; A. Bundy, Edinburgh; M. Burgin and V. Kuznetsov, Kiev; N. da Costa, Sao Paulo; M.L. Dalla Chiara, Firenze; L. Daston, Brandeis; J.W. Dauben, NY; A. Dress, Bielefeld; J. Echeverria, San Sebastian; A.W.F. Edwards, Cambridge; S. Feferman, Stanford; J. Flum, Freiburg; D. Gillies, London; G. Giorcello, Milan; I. Grattan-Guinness, Middlesex; J. Hernandez, Madrid; A. Ibarra, San Sebastian; H.J. Jahnke, Bielefeld; E. Knobloch, Berlin; L. Krüger, Göttingen; B. Lawvere, NY; M. Loi, Paris; G. Ludwig, Marburg; S. Mac Lane, Chicago; M.S. Mahoney, Princeton; J. Mosterin, Barcelona; C.U. Moulines, Berlin; I. Niiniluoto, Helsinki; M. Otte, Bielefeld; L. Pepe, Ferrara; M. Przelecki, Warszawa; V. Rantala, Tampere; M. Resnik, N. Carolina; E. Scheibe, Heidelberg; H.J. Schmidt, Osnabück; J.D. Sneed, Colorado; P. Suppes, Stanford; R. Thom, Paris; R. Torretti, Puerto Rico; J. Wolenski, Krakow.

* 28-29. Linear Algebra and its Applications, Miami University, Oxford, OH.

INVITED SPEAKERS: C. Curtis, Univ. of Oregon; G. Strang, MIT; H. Zassenhaus, Ohio State Univ.

CALL FOR PAPERS: Abstracts for contributed papers should be sent by June 1, 1990, to J. Skillings, Dept. of Math. and Stat., Miami Univ., Oxford, OH 45056.

INFORMATION: J.H. Skillings, Miami Univ., Dept. of Math. and Stat., Bachelor Hall, Oxford, OH 45056; 513-529-5818.

30-October 6. **Diophantische Approximationen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

October 1990

1-5. **Organisations et Theorie des Jeux**, Marseille, France. (Jan. 1990, p. 60)

1-5. **Third Joint Europe/U.S. Short Course in Hypersonics**, RWTH Aachen Univ. of Technology, Federal Republic of Germany. (Mar. 1990, p. 332)

5-6. **Math-History Conference**, LaCrosse, WI. (Jan. 1990, p. 60)

5-7. **Workshop on Partial Differential Equations**, Cornell Univ., Ithaca, NY. (Mar. 1990, p. 332)

7-13. **Arbeitsgemeinschaft Mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

8-12. **Congres Franco-Sovietique de Programmation Mathematique**, Marseille, France. (Jan. 1990, p. 60)

14-20. **Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

15-19. **Modeles pour L'Analyse des Donnees Multidimensionnelles**, Marseille, France. (Jan. 1990, p. 60)

15-19. **Tercer Congreso Nacional de Matemáticas**, San José, Costa Rica. (Feb. 1990, p. 225)

* 19-20. **Nineteenth Midwest Conference on Differential and Integral Equations**, Univ. of Missouri-Rolla, Rolla, MO.

INVITED SPEAKERS: T.A. Burton, C.C. Chicone, P.W. Elie, A.M. Fink, D.B. Hinton, J.L. Henderson, W.G. Kelley, Y. Sibuya.

INFORMATION: L.M. Hall, Dept. of Math. and Stat., Univ. of Missouri-Rolla, Rolla, MO 65401; 314-341-4911; c0635@umrvmb.bitnet. Deadline for abstracts of contributed papers: August 17, 1990.

20-21. **Eastern Section**, University of Massachusetts at Amherst, Amherst, MA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

21-27. **Mathematische Methoden In Der Robotik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

21-27. **Arithmetik der Körper**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

21-27. **International Functional Analysis Meeting on the Occasion of the Sixtieth Birthday of Professor M. Valdivia**, Peñíscola, Spain. (Oct. 1989, p. 1098)

22-25. **Fifth Jerusalem Conference on Information Technology (JCIT-5)**, Jerusalem, Israel. (Jan. 1990, p. 60)

26-27. **Statistical Mechanics at the 45th Parallel: Fourth Annual Meeting**, Université de Montréal, Canada. (Feb. 1990, p. 226)

28-November 3. **Mathematical Economics**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

29-November 2. **Trieste Conference on Integrable Systems**, Trieste, Italy. (Jan. 1990, p. 61)

29-November 2. **Algorithmes Parallele et Architectures Nouvelles**, Marseille, France. (Jan. 1990, p. 61)

29-November 2. **The International Conference "D-Modules and Microlocal Geometry"**, Lisbon, Portugal. (Mar. 1990, p. 333)

29-November 16. **Workshop on Mathematical Ecology**, Trieste, Italy. (Jan. 1990, p. 61)

31-November 3. **Latinamerican Seminar on Applications of Mathematics and Computer Science to Biology**, La Habana, Cuba. (Feb. 1990, p. 226)

November 1990

2-3. **Central Section Meeting of the AMS**, University of North Texas, Denton, TX.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

4-10. **Wahrscheinlichkeitsmaße auf Gruppen**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

5-7. **Second SIAM Conference on Linear Algebra in Signals, Systems & Controls**, San Francisco, CA. (Sep. 1989, p. 920)

* 6-7. **1990 ACM Conference on Critical Issues**, Arlington, VA.

PURPOSE: Many scientists fear that we are courting costly failures by

placing too much trust in computers to handle complexities that we do not fully understand and to model realities that defy our attempts at simplification. Leaders from science, engineering, business, economics, and government will try to map out better ways to deal with the risks and enhance the benefits of computer systems. The goal of the conference will be to reach a consensus on the major problems and develop an agenda for action.

ORGANIZERS: K. Duncan and W. Carlson.

INFORMATION: J. Adams, Association for Computing Machinery, 11 West 42nd St., New York, NY 10036; 212-869-7440.

9-11. **Third Annual Conference on Technology in Collegiate Mathematics**, The Ohio State Univ., Columbus, OH. (Mar. 1990, p. 333)

* 10. **Differential Geometry Day**, Eastern Illinois University, Charleston, IL.

INVITED SPEAKERS: R. Bishop, Univ. of Illinois; H. Donnelly, Purdue Univ.; C. Gordon, Washington Univ.; F. Xavier, Univ. of Notre Dame; K. Yang, Arkansas State Univ.

INFORMATION: J.F. Glazebrook, Dept. of Mathematics, Eastern Illinois University, Charleston, IL 61920; 217-581-6275.

10-11. **Far Western Section**, University of California, Irvine, CA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

12-16. **Supercomputing '90**, New York, NY. (Sep. 1989, p. 920)

12-16. **Workshop on Representations of Reductive Groups over Finite Fields**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

18-24. **Komplexitätstheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. **Stochastische Approximation Und Optimierungsprobleme In Der Statistik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. **Lineare Modelle Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

December 1990

3-8. **Multigrid Methods**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

3-5. **First International Symposium on Uncertainty and Analysis: Fuzzy Reasoning, Probabilistic Methods and Risk Management**, College Park, Maryland. (Oct. 1989, p. 1098)

3-7. **Sixteenth Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, Palmerston North, New Zealand. (Feb. 1990, p. 226)

3-7. **SINO-JAPANESE Joint Seminar on Nonlinear PDEs with Emphasis on Reaction-Diffusion Aspects.**, Taipei, Taiwan. (Jan. 1990, p. 61)

3-7. **Workshop on General Group Representation Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

9-15. **Allgemeine Ungleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

*15-19. **Curves and Surfaces: An Algorithmic Viewpoint**, Kent State Univ., Kent, OH.

INVITED SPEAKER: C.A. Michelli, T.J. Watson Research Center (I.B.M.).

INFORMATION: A.S. Cavaretta, Dept. of Math. Sciences, Kent State Univ., Kent, OH 44242; 216-672-2696; Internet: cavarett@cs.kent.edu..

16-22. **Mathematische Logik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

*17-21. **Non-linear Dispersive Wave Systems**, Univ. of Central Florida, Orlando, FL.

INVITED SPEAKER: T. Brooke Benjamin.

INFORMATION: L. Debnath, Univ. of Central Florida, Department of Mathematics, Orlando, FL 32816; 407-275-2478.

25-January 1. **Lineare Modelle Und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

Spring 1991. **IMACS International Symposium on Iterative Methods in Linear**

Algebra, Brussels Free Univ., Brussels, Belgium. (Mar. 1990, p. 334)

January 1991

*6-12. **Automorphe Formen und Anwendungen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: S.S. Kudla, College Park; J. Schwermer, Eichstätt.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

7-10. **Sixth Caribbean Conference in Combinatorics and Computing**, University of the West Indies, St. Augustine, Trinidad. (Jan. 1990, p. 61)

*13-19. **Combinatorial Optimization**, Oberwolfach, Federal Republic of Germany.

CHAIRMAN: R. Burkard, Graz; M. Grötschel, Augsburg.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

16-19. **Joint Mathematics Meetings**, San Francisco, CA. (including the annual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

*20-26. **Spektraltheorie Singulärer Gewöhnlicher Differentialoperatoren**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H.D. Nießen, Essen; A. Schneider, Dortmund; J. Weidmann, Frankfurt.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a per-

sonal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

*27-February 2. **Harmonische Analyse und Darstellungstheorie Topologischer Gruppen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: R.E. Howe, New Haven; E. Kaniuth, Paderborn.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

February 1991

*3-9. **Konstruktive Methoden in der Komplexen Analysis**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H.-P. Blatt, Eichstätt; D. Gaier, Gießen; R.S. Varga, Kent.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

*10-16. **Endlichdimensionale Lie-Algebren**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: M. Goze, Muhlhouse; O.H. Kegel, Freiburg.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is no possible. Mathematicians interested in a meeting should contact the Institute."

*10-16. **Affine Differentialgeometrie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: K. Nomizu, Providence; U. Pinkall, Berlin; U. Simon, Berlin.

INFORMATION: Mathematisches For-

schungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

- * 24-March 2. **Medical Statistics: Statistical Models for Longitudinal Data**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: N. Breslow, Seattle; J. Mau, Düsseldorf; M. Schumacher, Freiburg.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

- 25-March 1. **IEEE Computer Society COMPCON Spring '91**, San Francisco, CA. (Jan. 1990, p. 62)

March 1991

- * 3-9. **Partielle Differentialgleichungen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: J. Brüning, Augsburg; L. Hörmander, Lund; W. von Wahl, Bayreuth.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

- * 10-16. **Mathematische Stochastik**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: P.L. Davies, Essen; B.W. Silverman, Bath.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a

meeting should contact the Institute."

- 16-17. **Central Section**, Indiana University, South Bend, IN.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

- * 17-23. **Elementare und Analytische Zahlentheorie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H.-E. Richert, Ulm; W. Schwarz, Frankfurt; E. Wirsing, Ulm. INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

- 21-23. **Sixth S.E.A. Meeting, Southeastern Approximation Theorists Annual Meeting**, Memphis State Univ., Memphis, TN. (Mar. 1990, p. 334)

- 22-23. **Southeastern Section**, University of South Florida, Tampa, FL.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

- 22-24. **Fifth SIAM Conference on Parallel Processing for Scientific Computing**, Houston, TX. (Mar. 1990, p. 334)

- * 24-30. **Gewöhnliche Differentialgleichungen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H.W. Knobloch, Würzburg; J. Mawhin, Louvain-la-Neuve; K. Schmitt, Salt Lake City.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

- * 31-April 6. **Arbeitsgemeinschaft mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: N.N.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Ge-

schäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

April 1991

- * 7-13. **Algebraische Gruppen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: P. Slodowy, Stuttgart; T.A. Springer, Utrecht; J. Tits, Paris.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

- * 8-12. **Seventh International Conference on Data Engineering**, Kobe, Japan.

PURPOSE: The purpose of this conference is to provide a forum for the sharing of practical experiences and research advances from an engineering point of view among those interested in automated data and knowledge management.

CONFERENCE TOPICS: AI and knowledge based systems, applications and application systems, benchmarks and performance evaluation, design and human interfaces, data engineering tools and techniques, database design and modeling, database management and structure, deductive and extensive databases, distributed database systems, control, distributed database techniques, integrity and security techniques, objecting and discovery in databases, query oriented database systems, query languages and processing, scientific databases, supercomputer databases.

CALL FOR PAPERS: Each paper length should be limited to 8 proceedings pages, which is about 5000 words or 25 double spaced typed pages. Five copies of completed papers or panel proposals should be mailed before July 1, 1990 to: N.J. Cercone, Center for Systems Science, Simon Fraser Univ., Burnaby, British Columbia, Canada V5A 1S6; (604) 281-3229; nick@cs.sfu.ca.

14-20. Brauer Groups and Representation Theory of Finite Groups, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H. Opolka, Göttingen; F. Van Oystaeyen, Wilrijk; W. Scharlau, Münster.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

28-May 4. Deductive Systems, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: W.W. Bledsoe, Austin; G. Jäger, Bern; M.M. Richter, Kaiserslautern.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

May 1991

12-18. Nichtlineare Evolutionsgleichungen, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: S. Klainerman, Princeton; M. Struwe, Zürich.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

19-25. Differentialgeometrie im Grossen, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: W. Ballmann, Bonn; J.-P. Bourguignon, Palaiseau; W. Klingenberg, Bonn.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. Participants at

Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

*** 22-24. Second International Conference on Algebraic Methodology and Software Technology**, (AMAST), Iowa City, IA.

PURPOSE: The goal of the conference is to consolidate the trend of using algebraic methodology as a foundation for software technology showing that universal algebra provides a practical mathematical alternative to ad hoc approaches used in software development.

CALL FOR PAPERS: Talks reporting research in algebra suitable as a foundation for software technology as well as software technologies developed by means of algebraic methodologies are welcome. Submit a two page abstract (including a few citations of relevant work) of your talk to: AMAST Conference, Computer Science Dept., The University of Iowa, Iowa City, IA 52242 by January 1, 1991.

INFORMATION: In Canada: T. Müldner, Acadia Univ., Jodrey School of Comp. Sci., Wolfville, Nova Scotia, Canada B0P 1X0; muldner@acadia.bitnet; In Europe: M. Nivat, Univ. Paris 7, 2, Place Jussieu, 75005 Paris, France; (1) 43 25 98 74; In US: T. Rus, Univ. of Iowa, Dept. of Comp. Sci., Iowa City, IA 52242; (319)335-0694; email: rus@herky.cs.uiowa.edu.

*** 26-June 1. Optimalsteuerung und Variationsrechnung-Optimal Control**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: R. Bulirsch, München; A. Miele, Houston; J. Stoer, Würzburg; K. Well, Oberpfaffenhofen.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

June 1991

*** 2-8. Diskrete Geometrie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: L. Danzer, Dortmund; G.C. Shephard, Norwich.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

*** 9-15. Singuläre Störungsrechnung**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: W. Jäger, Heidelberg; N.N. INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

*** 30-July 6. Elliptische Operatoren auf Singulären und Nichtkompakten Mannigfaltigkeiten**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: J. Brüning, Augsburg; R. Melrose, Cambridge.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

July 1991

*** 8-12. Second International Conference on Industrial and Applied Mathematics**, Washington, DC. (Please note changes from Nov. 1988, p. 1389)

PROGRAM: The conference organizers are developing a program that will focus worldwide attention on the importance of mathematical and computational methods in the solution of real world problems. A major exposition of computer hardware and software exhibits and demonstrations that will enable you to explore state-of-the-art technology is also planned.

CONFERENCE TOPICS: Presentations

are solicited in all areas of applied and computational mathematics, computer science, applied probability and statistics, scientific computing, and applications in engineering and the biological, chemical, and physical sciences.

INVITED SPEAKERS: J.M. Ball, G.I. Barenblatt, M. Brady, A.R. Conn, W. Eckhaus, A. Fasano, G.H. Golub, M. Gröetschel, T.J.R. Hughes, N.K. Karmarkar, K. W. Kirchgässner, P.-L. Lions, Y.F. Meyer, M. Mimura, J.D. Murray, G. Ruget, E. Tardös, D.J. Wallace, M.F. Wheeler, H. Yserentant.

CALL FOR PAPERS: Authors will have approximately 15 minutes to present contributed papers, with an additional five minutes for questions. To contribute, you must submit a summary not exceeding 75 words on an ICIAM 91 contributed paper/poster presentation form. Deadline for submission is September 30, 1990.

INFORMATION: ICIAM 91 Conference Manager, c/o SIAM, 3600 University City Science Center, Philadelphia, PA 19104-2688; email:

iciam@wharton.upenn.edu; FAX: 215-386-7999; tel: 215-382-9800.

*** 8-14. ICOR '91 International Conference on Radicals, Szekszárd, Hungary.**

INFORMATION: L. Márki or R. Wiegandt, Mathematical Institute, Hungarian Academy of Science, Pf.127, H-1364 Budapest, Hungary.

*** 14-20. Dynamische Systeme, Oberwolfach, Federal Republic of Germany.**

CHAIRMEN: J. Moser, Zürich; E. Zehnder, Zürich.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

*** 22-26. Thirteenth IMACS World Congress on Computation and Applied Mathematics, Trinity College, Dublin University, Dublin, Ireland. (Please note changes from Nov. 1989, p. 1254)**

DEADLINES: Proposals to organize a session: As soon as possible; Phase I submissions due: August 1, 1990; Phase II submissions due: October 1, 1990; Late submissions: December 1, 1990.

*** 28-August 3. Gruppen und Geometrien, Oberwolfach, Federal Republic of Germany.**

CHAIRMEN: M. Aschbacher, Pasadena; W.M. Kantor, Eugene; F. Timmesfeld, Gießen.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstrabe 24, D-7800 Freiburg im Breisgau. "Participants at Oberwolfach meetings do need a personal invitation. Without a personal invitation participation is not possible. Mathematicians interested in a meeting should contact the Institute."

August 1991

*** 3-7. Interamerican Conference on Mathematics Education, Univ. of Miami, Coral Gables, FL.**

INFORMATION: U. D'Ambrosio, Institute of Math., Univ. Estadual de Campinas, CP 6063 (13081) Campinas (SP), Brazil.

September 1991

*** 10-13. IFAC/IMACS Symposium on Fault Detection, Supervision and Safety for Technical Processes-SAFEPROCESS '91, Baden-Baden, Federal Republic of Germany.**

INFORMATION: Dipl. Ing. H. Wiefels, VDI/VDE-GMA, Postfach 1139, D-4000 Dusseldorf 1, Federal Republic of Germany.

*** 16-19. Fourth SIAM Conference on Applied Linear Algebra, Univ. of Minnesota, Minneapolis, MN.**

ORGANIZER: R. Brualdi, Univ. of Wisconsin-Madison.

INFORMATION: SIAM, Conference Coordinator, Dept. CC0190, 3600 University City Science Center, Philadelphia, PA 19104-2688; tel 215-382-9800; Fax 215-386-7999; email: siam@wharton.upenn.edu.

*** 23-29. Sixth Symposium on Classical Analysis, Kazimierz Dolny, Poland.**

PROGRAM: Discussions will take place on the results and problems in such fields as: several complex variables (especially L2-methods), Riemannian and Hermitian geometry, spectral theory in Hilbert space, probability, applications in the mathematical physics. Particular consideration will be given to the interrelation of ideas from different areas.

INFORMATION: T. Mazur, Technical Univ., Dept. of Math., Młeczewskiego 29, 26-600 Radom, Poland.

October 1991

12-13. Eastern Section, Temple University, Philadelphia, PA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

25-26. Central Section, North Dakota State University, Fargo, ND.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

March 1992

27-28. Central Section, Southwest Missouri State University, Springfield, MO.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

New AMS Publications

New Journal

LENINGRAD MATHEMATICAL JOURNAL

The Society is pleased to announce the *Leningrad Mathematical Journal*, a cover-to-cover translation into English of *Алгебра и анализ*. With research papers, expository surveys, and book reviews, the *Leningrad Mathematical Journal* contains contributions by some of the most prominent Soviet mathematical scientists. Readers will appreciate this opportunity to keep abreast of Soviet mathematical developments in all areas of mathematics.

The mathematics section of the Academy of Sciences of the USSR began publishing the Russian-language journal in 1989 via the Leningrad branch of "Nauka". The topics explored in the first issues of the *Leningrad Mathematical Journal* range over a wide array of mathematical areas. A brief sampling includes: probability methods in the theory of conformal mappings, quantization of Lie groups and Lie algebras, almost cocommutative Hopf algebras, valence bonds in quasicrystals, the dynamics of analytic transformations, algebraic K-theory, and compact four-dimensional exotica.

Members of the Editorial Board are: A. N. Andrianov (Deputy Editor-in-Chief), V. M. Babich, M. Sh. Birman, O. Ya. Viro, S. P. Merkur'ev, N. K. Nikol'skiĭ (Deputy Editor-in-Chief), A. P. Oskolkov (Executive Secretary), A. N. Parshin, V. N. Popov (Deputy Editor-in-Chief), M. A. Semenov-Tyan-Shanskii, A. O. Slisenko, A. A. Suslin, N. N. Ural'tseva, D. K. Faddeev (Editor-in-Chief), and V. P. Khavin.

The publication of the *Leningrad Mathematical Journal* is part of a larger effort by the AMS to stimulate interactions between American mathematicians and their Soviet colleagues. In this spirit, the Society is proud to offer this new journal.

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MATRIX THEORY AND APPLICATIONS

Charles R. Johnson, Editor

(Proceedings of Symposia in Applied Mathematics, Volume 40)

This volume contains the lecture notes prepared for the AMS Short Course on Matrix Theory and Applications, held in Phoenix in January, 1989. Matrix theory continues to enjoy a renaissance that has accelerated in the past decade, in part because of stimulation from a variety of applications and considerable interplay with other parts of mathematics. In addition, the great increase in the number and vitality of specialists in the field has dispelled the popular misconception that the subject has been fully researched.

The purpose of the Short Course, which attracted approximately 140 participants, was to present a sample of the ways in which modern matrix theory is stimulated by its interplay with other subjects, such as combinatorics, probability theory, statistics, operator theory and control theory, algebraic coding theory, partial differential equations, and analytic function theory. Among the themes in this volume are the notion of majorization, the trend away from "basis-free" point of view, problem-dependent symmetries, and the synergy between matrix theory and systems theory.

The immense variety of tools and problems in this area illustrates one reason for using the term "matrix theory" or "matrix analysis" instead of "linear algebra"; a large portion of current work is neither primarily linear nor primarily algebraic in nature. The remarkable breadth of interest in this subject seems to point to future developments as fruitful and unexpected as in the past.

Contents

Richard A. Brualdi, *The many facets of combinatorial matrix theory*; Persi Diaconis, *Patterned matrices*; Joseph A. Ball, Israel Gohberg, and Leiba Rodman, *Tangential interpolation problems for rational matrix functions*; Roger A. Horn, *The Hadamard product*; Charles R. Johnson, *Matrix completion problems: A survey*; Arunava Mukherjee, *The role of nonnegative idempotent matrices in certain problems in probability*; Ingram Olkin, *Interface between statistics and linear algebra*.

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CLASSICAL ASPHERICAL MANIFOLDS

F. Thomas Farrell and Lowell Edwin Jones

(CBMS Regional Conference Series, Number 75)

Supported by the National Science Foundation

Aspherical manifolds—those whose universal covers are contractible—arise classically in many areas of mathematics. They occur in Lie group theory as certain double coset spaces and in synthetic geometry as the space forms preserving the geometry.

This volume contains lectures delivered by the first author at an NSF-CBMS Regional Conference on K-Theory and Dynamics, held in Gainesville, Florida in January, 1989. The lectures were primarily concerned with the problem of topologically characterizing classical aspherical manifolds. This problem has for the most part been solved, but the 3- and 4-dimensional cases remain the most important open questions; Poincaré's conjecture is closely related to the 3-dimensional problem. One of the main results is that a closed aspherical manifold (of dimension $\neq 3$ or 4) is a hyperbolic space if and only if its fundamental group is isomorphic to a discrete, cocompact subgroup of the Lie group $O(n, 1; \mathbb{R})$. One of the book's themes is how the dynamics of the geodesic flow can be combined with topological control theory to study properly discontinuous group actions on R^n .

Some of the more technical topics of the lectures have been deleted, and some additional results obtained since the conference are discussed in an epilogue. The book requires some familiarity with the material contained in a basic, graduate-level course in algebraic and differential topology, as well as some elementary differential geometry.

Contents

The structure of manifolds from a historical perspective; Flat Riemannian manifolds and infrasolvmanifolds; The algebraic K-theory of hyperbolic manifolds; Locally symmetric spaces of noncompact type; Existence of hyperbolic structures; Epilogue.

1980 *Mathematics Subject Classifications*: 57R55, 18F25, 22E40, 53C20

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LA DICHOTOMIE ELLIPTIQUE-HYPERBOLIQUE EN HOMOTOPIE RATIONNELLE

Y. Felix

(Astérisque, Number 176)

The homotopy groups $\pi_i(X)$ of a finite 1-connected CW complex X are finitely generated abelian groups. Therefore $\pi_i(X) = \mathbb{Z}^{n_i} \oplus T_i$, where T_i is a finite group. There are then two possibilities: either all the n_i , except a finite number, are zero, or there exists an infinite sequence of nonzero n_i . In the first case, the space is called elliptic: the Euler-Poincaré characteristic is nonnegative and the cohomology satisfies Poincaré duality. In the second case, the space is called hyperbolic and the sequence $\sum_{i=1}^{\infty} n_i$ has an exponential growth. In the text, the study of the dichotomy is then extended to the structure of the Lie algebra $\pi_*(\Omega X) \otimes \mathbb{Q}$.

Contents

Définition de la catégorie de Lusternik-Schnirelmann; Espaces rationnels et modèles minimaux; Le mapping theorem; cat_0 et les modèles minimaux de Sullivan; Espaces π -finis; La croissance exponentielle; L'algèbre de Lie $\pi_*(\Omega X) \otimes \mathbb{Q}$; Cohomologie d'une algèbre de Lie graduée; Opération d'holonomie d'une fibration; Catégorie d'une application; Profondeur des algèbres de Lie; Croissance des idéaux de $\pi_*(\Omega X) \otimes \mathbb{Q}$; Profondeur un; La dichotomie; Bibliographie; Index terminologique; Index des symboles.

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SÉMINAIRE BOURBAKI, VOLUME 1988/89, EXPOSÉS 700-714

(Astérisque, Number 177-178)

Comme les précédents volumes de ce Séminaire, celui-ci contient des exposés de synthèse sur des sujets d'actualité: quatre sur les Groupes de Lie et leurs représentations, un de Géométrie riemannienne, deux sur les Feuilletages, un de Géométrie algébrique, un de Géométrie arithmétique, un de Géométrie symplectique, un de Théorie des nombres, un de Logique et un de Physique théorique.

On y fait, entre autres, le point sur l'invariant de Godbillon-Vey, les feuilletages riemanniens, les fonctions L_p -adiques, les groupes associés aux algèbres de Kac-Moody, les modèles minimaux des variétés algébriques de dimension 3 et la théorie d'Arakelov.

Contents

Jacques Tits, *Groupes associés aux algèbres de Kac-Moody*; John Coates, *On p-adic L-functions*; Laurent Clozel, *Nombres de Tamagawa des groupes semi-simples* [d'après Kottwitz]; Yves Colin de Verdière, *Distribution de points sur une sphère* [d'après Lubotzky, Phillips et Samet]; Krzysztof Gawędzki, *Conformal field theory*; Pierre Bérard, *Variétés Riemanniennes isospectrales non isométriques*; Étienne Ghys, *L'invariant de Godbillon-Vey*; André Haefliger, *Feuilletages Riemanniens*; Christian Kassel, *Le résidu non commutatif* [d'après M. Morita]; Gérard Laumon, *Faisceaux caractères* [d'après Lusztig]; Patrick Dehornoy, *La détermination projective* [d'après Martin, Steel et Woodin]; Guy Henniart, *Formes de Maass et représentations admissibles* [d'après Blasius, Clozel, Harris, Ramakrishnan et Taylor]; János Kollár, *Minimal models of algebraic threefolds: Mori's program*; Christophe Soulé, *Géométrie d'Arakelov des surfaces arithmétiques*; Claude Viterbo, *Capacités symplectiques et applications* [d'après Eliashberg, Gromov];

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THÉORIE DE HODGE

(Astérisque, Number 179-180)

This volume contains several contributions of a conference on Hodge Theory held in Luminy in June 1987.

There is an exposition of the recent quite spectacular results on intersection cohomology with values in a polarized variation of Hodge structure, and with constant values on locally symmetric spaces, on mixed Hodge modules and perverse sheaves. Several subjects at the border line of Hodge Theory are presented as well: extensions of variations of Hodge structure, applications to Hodge Theory to vanishing theorems and to singularities.

Contents

Daniel Barlet, *Asymptotic filtration and poles of $\int_X |f|^{2\lambda}$* ; James A. Carlson and Richard M. Hain, *Extensions of variations of mixed Hodge structure*; Eduardo Cattani and Aroldo Kaplan, *Degenerating variations of Hodge structure*; Hélène Esnault and Eckart Viehweg, *Vanishing and non vanishing theorems*; Helmut A. Hamm, *Cohomology with coefficients in $Z(p)$ and de Rham cohomology: examples*; Morihiko Saito, *"Introduction to mixed modules"*; Joseph H. M. Steenbrink, *The spectrum of hypersurface singularities*; Sampei Usui, *Type I degeneration of Kuranishi surfaces*; Steve Zucker, *L^2 -cohomology and intersection homology of locally symmetric varieties, III*.

1980 Mathematics Subject Classification: 14

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AMS Reports and Communications

Recent Appointments

Committee members' terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.

Haynes Miller has been appointed chair of the *Editorial Boards Committee* by President William Browder. Continuing members of the committee are Linda Keen (1992), Carlos Kenig (1991), Richard M. Schoen (1990), Barry Simon (1992), and Daniel Zelinsky (1991).

Marc A. Rieffel (1991), by recommendation of the Editorial Boards Committee, has been elected by the Council to the *Mathematical Surveys and Monographs Editorial Committee*. Continuing members of the committee are Victor W. Guillemin (1992), David S. Kinderlehrer (1991), and M. Susan Montgomery (1990), chair.

The Annual Meeting in Louisville

The January 1990 Joint Mathematics Meetings, including the 96th Annual Meeting of the American Mathematical Society, the 73rd Annual Meeting of the Mathematical Association of America, and the 1990 annual meetings of the Association for Women in Mathematics and the National Association for Mathematicians, were held January 17–20 (Wednesday–Saturday), 1990, in Louisville, Kentucky. Scientific sessions took place in the Louisville Convention Center and the Hyatt Regency Louisville. There were 3,147 registrants, including 2,240 members of the Society.

AMS-MAA Invited Addresses. By invitation of the AMS-MAA Joint Program Committee (Hugh L. Montgomery, David P. Roselle, Mary Ellen Rudin, and Peter Sarnak, Chairman), four speakers addressed the AMS and MAA on the history and development of mathematics. The names of the speakers, their affiliations, and the titles of their talks were as follows: JOHN BARWISE, Stanford University, *Non-wellfounded sets and their applications*; CHARLES W. CURTIS, University of Oregon, *A century of representation theory of finite groups*; BARRY SIMON, California Institute of Technology, *Fifty years of eigenvalue perturbation theory*; NOLAN R. WALLACH, Rutgers University, *Some applications of group representations*.

The four speakers were introduced by Sun-Yung Alice Chang, Ramesh A. Gangolli, C. Ward Henson, and Gerald J. Janusz, respectively.

Sixty-third Josiah Willard Gibbs Lecture. The 1990 Gibbs Lecture was presented by George B. Dantzig of Stanford University. The title of his lecture was *The wide world of pure mathematics that goes by other names*. Professor Dantzig was introduced by William Browder, President of the Society.

Colloquium Lectures. A set of three lectures was given by Schlomo Sternberg, Harvard University. The title of his lectures was *Some thoughts on the interaction between group theory and physics*. The presiders at these three lectures were William Browder, Sun-Yung Alice Chang, and William P. Thurston.

Invited Addresses. By invitation of the AMS Program Committee

for National Meetings, there were six fifty-minute invited addresses. The names of the speakers, their affiliations, and the titles of their talks are as follows: SUN-YUNG ALICE CHANG, University of California, Los Angeles, *Geometric spectral and inverse spectral problems*; ISRAEL C. GOHBERG, Tel Aviv University, Israel, *Linear operators, matrix functions and control*; MIKE HOPKINS, Massachusetts Institute of Technology, *Stable homotopy theory*; HENRYK IWANIEC, Rutgers University, *Problems and methods in analytic number theory*; JANOS KOLLAR, University of Utah, *The structure of algebraic threefolds*; I. M. SIGAL, University of Toronto and the University of California, Irvine, *Quantum many body problem*.

The six speakers were introduced by Peter Perry, Joseph Ball, Ethan Devinatz, Hugh L. Montgomery, Charles H. Clemens, and Joseph Conlon, respectively.

Special Sessions. By invitation of the same committee, there were eighteen special sessions of selected twenty-minute papers. The topics of the sessions, and the names and affiliations of the organizers are listed below. *Linear operators, matrix functions and control*, JOSEPH BALL, Virginia Polytechnic Institute and State University, and ISRAEL G. GOHBERG, Tel Aviv University.

The Shrodinger equation, JOSEPH CONLON, University of Michigan.

Multivariable operator theory, RAUL E. CURTO and PAUL S. MULLER, University of Iowa.

Homotopy theory, ETHAN DEVINATZ and MIKE HOPKINS, University of Chicago.

Group representations and operator algebras, ROBERT S. DORAN, Texas Christian University.

Functional equations and their applications, BRUCE R. EBANKS, University of Louisville.

History of mathematics, FLORENCE D. FASANELLI, National Science Foundation, and VICTOR J. KATZ, University of the District of Columbia.

Control of infinite dimensional systems, ROBERT E. FENNEL, Clemson University, and SUZANNE MARIE LENHART, University of Tennessee.

Geometric function theory in one and several complex variables, CARL H. FITZGERALD, University of California, San Diego, and TED J. SUFFRIDGE, University of Kentucky.

Oscillation theory in ordinary differential equations, GARY D. JONES, Murray State University.

Topology in computer graphics and image processing, EFIM D. KHALISKY, College of Staten Island, T. YUNG KONG, Queens College, and RALPH KOPPERMAN, City College, CUNY.

Algebraic geometry, JANOS KOLLAR, University of Utah.

Semi-group theory, INESSA LEVI and W. WILEY WILLIAMS, University of Louisville.

Function theoretic methods in differential equations, PETER MCCOY, United States Naval Academy.

Optimization and nonlinear analysis, LYNN MCLINDEN, University of Illinois, Urbana, and JAY S. TREIMAN, Western Michigan University.

Analytic number theory, HUGH L. MONTGOMERY, Univ. of Michigan.

Geometric spectral and inverse spectral problems, PETER A. PERRY, University of Kentucky.

Markov processes and stochastic analysis, PHILIP E. PROTTER, Purdue University.

Contributed papers. There were twenty-nine AMS sessions for contributed 10-minute papers. The following mathematicians served as presiding officers for these sessions: J. Marshall Ash, Scott Chapman, Shannon S. Cobb, Robin Cunningham,

Joyati Debnath, George T. Gilbert, Maria Girardi, Robert Gordon, T. Hesterberg, Charles S. Holmes, Melvin Holmes, Rodney Hood, Diane L. Johnson, Gene D. Johnson, Sandra N. Kerr, Alexandra Kurepa, Lee Larson, Bruce M. Landman, John A. Morrison, M. Nourimagahadam, Timothy Peil, Margaret L. Reese, Emilio Roxin, John M. Russell, Erin M. Schram, Donald R. Snow, Monty Strauss, Karel Stroethoff, G. Rubin Thomas, Jerry E. Vaughn, Denis A. White, and Eric Wingler.

AMS-MAA Science and Government Speakers. The presidents of the AMS and the MAA, William Browder and Lida K. Barrett, invited Luther Williams, Senior Science Advisor, National Science Foundation, and Alvin Trivelpiece, Secretary of Energy, to give one-hour addresses to the Joint Meetings in Louisville. The title of Luther Williams' talk was *Mathematics: Keystone of modern science and technology*. The title of Alvin Trivelpiece's talk was *Revitalizing mathematics education: A national imperative*.

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*As a result of his election to the Executive Committee, he will be a Member-at-Large in 1990 and 1991.

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Miscellaneous

Personal Items

Andrew M. Odlyzko, the head of AT&T Bell Laboratories' Communication and Computer Systems Department, delivered the eighth Leonidas Alaoglu Memorial Lecture in Mathematics at the California Institute of Technology.

Deaths

Melvin Bloom, Professor Emeritus of Miami University, died on September 11, 1989, at the age of 85. He was a member of the Society for 42 years.

Michio Kuga, of SUNY at Stony Brook, died on February 14, 1990, at the age of 61. He was a member of the Society for 16 years.

Sim Lasher, Associate Professor Emeritus of the University of Illinois at Chicago, died on January 5, 1990, at the age of 73. He was a member of the Society for 51 years.

Donald H. Rock, of St. Paul, Minnesota, died on November 4, 1989, at the age of 78. He was a member of the Society for 50 years.

Nicholas Solimene, of Wood Haven, New York, died on Decem-

ber 27, 1989, at the age of 70. He was a member of the Society for 10 years.

Irving Sussman, Professor Emeritus of Santa Clara University, died on February 18, 1990, at the age of 82. He was a member of the Society for 45 years.

Visiting Mathematicians
Luis Ribes (Carleton University, Ottawa, Canada), Universidad Aut6noma de Madrid, Madrid, Spain. August 1990 to July 1991, algebra.

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Some Mathematical Questions in Biology: MODELS IN POPULATION BIOLOGY

Alan Hastings, Editor

(Lectures on Mathematics in the Life Sciences, Volume 20)

Population biology has had a long history of mathematical modeling. The 1920s and 1930s saw major strides with the work of Lotka and Volterra in ecology and Fisher, Haldane, and Wright in genetics. In recent years, much more sophisticated mathematical techniques have been brought to bear on questions in population biology. Simultaneously, advances in experimental and field work have produced a wealth of new data. While this growth has tended to fragment the field, one unifying theme is that similar mathematical questions arise in a range of biological contexts.

This volume contains the proceedings of a symposium on Some Mathematical Questions in Biology, held in Chicago in 1987. The papers all deal with different aspects of population biology, but there are overlaps in the mathematical techniques used; for example, dynamics of nonlinear differential and

difference equations form a common theme. The topics covered are cultural evolution, multilocus population genetics, spatially structured population genetics, chaos and the dynamics of epidemics, and the dynamics of ecological communities.

1980 Mathematics Subject Classifications: 92A10, 92A15
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POSITIONS AVAILABLE

CALIFORNIA

**UNIVERSITY OF CALIFORNIA
IRVINE**
Department of Mathematics
Irvine, CA 92717

The University of California at Irvine has made a significant commitment for the development of the mathematics department. A number of faculty appointments will be made over the next few years. These include:

1. At least five full time positions at any of the tenured professorial levels. The Department is particularly interested in areas of Algebra, Analysis, Applied Mathematics, Geometry, Mathematical Physics, Numerical Analysis-Scientific Computing, Probability, and Topology. Selection will be based on research experience and teaching ability.
2. At least one full time tenure track Assistant Professor position. Candidates must have a Ph.D. and a research record either in Mathematical Physics or Differential Geometry.

Applications must include curriculum vitae, bibliography and three letters of reference. The COMMITTEE ON STAFFING will solicit supplementary letters of reference. Please send applications to the COMMITTEE ON

STAFFING at the above address.

UC Irvine is an Affirmative Action/Equal Opportunity Employer.

COLORADO

UNITED STATES AIR FORCE ACADEMY
Department of Mathematical
Sciences
Visiting Professor

The Department of mathematical Sciences of the United States Air Force Academy invites nominations and applications for a Visiting Professor position. We seek a Professor with extensive experience teaching undergraduate mathematics, statistics or operations research and a strong record of scholarly activity. Duties will include reviewing our academic programs, teaching undergraduate courses and promoting our research programs. Applicants should have a demonstrated commitment to undergraduate research and education. The appointment is usually for one year and will begin in July 1991. Inquiries are welcome for Visiting Professor positions for subsequent years. Salary is commensurate with qualifications. To apply, please send nominations (to include resume and references) by 1 May 1990 to: Chairman, Department of Mathematical Sciences, United States Air Force Academy, CO 80840-5701.

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ILLINOIS

**SOUTHERN ILLINOIS UNIVERSITY
at EDWARDSVILLE**
Mathematics and Statistics
Edwardsville, IL 62026-1653

SIUE, a state university 20 miles from downtown St. Louis, MO., a major cultural and educational center, invites applications for one tenure-track and one visiting position with rank open beginning Sept. 1990. Only applicants who have a doctorate, or equivalent experience, or will complete Ph.D. requirements by Sept. 1, 1990 will be considered. We seek applicants with excellent research accomplishments/potential and a strong commitment to teaching. Salary is competitive and based on qualifications and experience. Direct inquiries to Search Committee Department of Mathematics and Statistics, SIUE, Edwardsville, IL 62026-1653. SIUE is an AA/EEO employer.

MASSACHUSETTS

BOSTON UNIVERSITY
Mathematics

Mathematics, Assistant Professor, Ph.D. or Ed.D. required. Boston University College of Basic Studies is instituting a new general education mathematics program for freshmen; tenure-track teaching positions available September, 1990. Salary negotiable. Deadline for applications 20 May 1990 but early applications are encouraged and will be acted on as soon as all recommendations are received. Send resume and three recommendations to: Professor William E. Davis, Jr., Chairman, Division of Science and Mathematics, College of Basic Studies, Boston University, 871 Commonwealth Avenue, Boston, MA 02215. An Equal Opportunity, Affirmative Action Employer.

SMITH COLLEGE
Assistant Professor
Mathematics Department

Smith College will have a one-year visiting position in mathematics for 1990-91 at the rank of entry-level Assistant Professor. Teaching load will be five courses. Ph.D. preferred. Applications will be accepted until the position is filled. Please send vitae and letters addressing both teaching and research to: Department of Mathematics Search Committee, Clark Science Center, Smith College, Northampton, MA 01063. Smith College is an EOE/AA Employer. Minorities and women are encouraged to apply.

WORCESTER POLYTECHNIC INSTITUTE

The Department of Mathematical Sciences will have several tenure track positions at all levels for fall of 1990. These positions require a strong research record or potential and evidence of quality teaching. Fields of interest are numerical analysis, computational fluid mechanics, nonlinear PDE, optimization, control theory, optimal design, dynamical systems, applied discrete mathematics, operations research, and statistics/applied probability.

WPI, the nation's third oldest college of science and engineering, offers degrees through the Ph.D. The Mathematical Sciences Department currently offers an undergraduate and master's degree in applied mathematics. Worcester, Massachusetts is the second largest city in New England, approximately 40 miles west of Boston.

Interested applicants should send a curriculum vita to: Samuel M. Rankin, III, Head, Department of Mathematical Sciences, 100 Institute Rd., Worcester, MA 01609. Applications will be accepted until the positions are filled. EOE/AA.

NEVADA
UNIVERSITY OF NEVADA
Tenured Professor and Chairman in
Mathematical Sciences

The Department of Mathematical Sciences at the University of Nevada, Las Vegas has a vacancy for a tenured professor and chairman. Responsibilities include all aspects of departmental administration, teaching, research and development, to include strengthening both undergraduate and graduate programs. Qualifications include a Ph.D. in Mathematics, statistics or related areas as well as a successful record in teaching and research are required. Past experience, or a strong interest in administration is necessary. Salary will be commensurate with the candidate's experience and qualifications.

The University of Nevada, Las Vegas is a growing, urban university with an enrollment of approximately 16,000 students located in metropolitan Las Vegas. The University will be housing a supercomputer center.

Interested applicants should submit a letter of application, current resume, photocopies of transcripts, and five letters of reference to the Search Committee for Chairman, Department of Mathematical Sciences, University of Nevada, Las Vegas, Las Vegas, Nevada 89154. Completed applications will be reviewed when received. The search will continue until the position is filled. Eligibility for U.S. Employment will be required prior to employment. UNLV is an EEO/AA employer.

NEW YORK
POTSDAM COLLEGE
Chair, Department of Computer and
Information Sciences

Applications are sought for the position of Chair of the Department of Computer and Information Sciences at Potsdam College of the State University of New York.

The Department is one of seventeen in the School of Liberal Studies, the largest of the three schools of Potsdam College. Currently there are 10 full time faculty and 200 majors in the Department.

Preference will be given to individuals possessing a Ph.D. in Computer Science though applicants with Ph.D.'s in closely related fields and substantial graduate preparation in computer science (at least a Master's degree) will also be considered. Some industrial experience would be welcome. Rank is negotiable, salary and fringe benefits are very competitive. Responsibilities are for the academic year.

The successful candidate should have a clear vision of an undergraduate computer science program appropriate to a selective liberal arts college whose primary mission is teaching and should possess the leadership and administrative skills needed to make this vision a reality. A strong record of successful undergraduate teaching and active scholarship are expected.

Applicants should provide a letter discussing how their education and background have prepared them to fulfill the responsibilities of this position as described, a current resume, the names, addresses and telephone numbers of three to five references to

Dr. Richard J. Del Guidice
 Dean
 School of Liberal Studies
 Potsdam College
 Potsdam, N.Y. 13676

Deliberations will begin 15 April and continue until the position is filled. Potsdam College actively seeks applications from women and minority candidates. AA/EOE.

ST. JOHN'S UNIVERSITY
NOTRE DAME COLLEGE
Division of Mathematics and Science

Applications are invited for a tenure-track position at the Assistant/Associate Professor level beginning September 1990.

Applicants must hold the Ph.D. degree in Mathematics and will be expected to teach a variety of undergraduate courses in

mathematics and, desirably, basic computer science. Responsibilities will also include continuing research, scholarly activities, and advisory service. Salary commensurate with qualifications. Screening will begin March 1990.

Send letter of application with curriculum vita and letters of recommendation to Dr. Thomas J. Thomas; Chairman of Division of Mathematics and Science; Notre Dame College; St. John's University; 300 Howard Avenue; Staten Island, N.Y. 10301. St. John's is EO/AA employer.

OKLAHOMA
THE UNIVERSITY OF OKLAHOMA
Department of Mathematics

Applications are invited for one or more positions at the Assistant Professor level (or higher) in Mathematics beginning Fall 1990. Candidates must have a Ph.D. degree, demonstrated excellence in research and potential for high-quality teaching. Strong candidates in all areas will be considered with preference given to research interests compatible with those of our current faculty. Duties include research, normally teaching 5 credit hours per semester, and Department and University service appropriate to rank. Salary and rank will be commensurate with qualifications and experience. There may be visiting positions. Applicants should send their vita and have at least three letters of reference sent to Dr. Ruediger Landes, Search Committee Chair, Department of Mathematics, University of Oklahoma, 601 Elm, Room 423, Norman, Oklahoma 73019-0315. Initial screening begins December 15, 1989 and every two weeks thereafter. Applications will be accepted until the position(s) are filled. The University of Oklahoma is an Affirmative Action/Equal Opportunity Employer.

THE UNIVERSITY OF OKLAHOMA
Applied Non-Linear Analysis
Applied Mathematics
Position (CAPS) Related

The University of Oklahoma seeks a (tenure track) Assistant Professor (or higher) with speciality in Applied Non-Linear Analysis. Ph.D. in Mathematics is required. Experience in fluid dynamics and numerical and computational experience are desirable. Salary for excellence in mathematics teaching and research is required. Competitive salary the mathematical support of the Center for Analysis and Prediction of Storms. A Science and Technology Center at the University of Oklahoma.

Oklahoma funded by the National Science Foundation. Applicants should send a letter of application, a complete vita, and have three letters of reference sent to: Andy R. Magid, Chair, Applied Analysis Search Committee, Department of Mathematics, University of Oklahoma, 601 Elm, Room 423, Norman, Oklahoma 73019-0315. Closing date for applications is December 20, 1989 and every two weeks thereafter until the position is filled. The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

TEXAS

LAMAR UNIVERSITY Beaumont, Texas

The Department of Mathematics seeks applications for a tenure-track Assistant/Associate Professor position beginning Fall 1990. Applicants must hold an earned Ph.D., should be active researchers in analysis and/or applied mathematics, and have a strong commitment to teaching.

Lamar is a state supported educational and research institution of approximately 12,000 students. The Department, which is located within the College of Engineering, offers the B.A., B.S., and M.S. degrees in Mathematics and has 16 full-time faculty.

For the approximately 250,000 people in the Beaumont area, there are eight museums, a symphony orchestra, ballet, opera, and other theatrical productions. Other facilities and events are found in Houston 85 miles west. Nearby outdoor recreational opportunities include two of the largest freshwater lakes in Texas, the Big Thicket National Preserve, four national forests, the Gulf of Mexico, and a large inland saltwater lake.

Salary and rank are commensurate with qualifications and experience. Send a resume and three letters of recommendation to: Dr. John R. Cannon, Chair, Department of Mathematics, Lamar University; P.O. Box 10047; Beaumont, TX 77710. Full consideration will be given to applications received before May 1, 1990. Lamar is an EEO/AA employer.

WASHINGTON

OLYMPIC COLLEGE Mathematics

Teaching faculty member, full-time, tenure-track position. Provide instruction in Mathematics, assist in curriculum planning and development and student advising. May include evening instruction. A Master's Degree in Mathematics or Mathematics Education is required and successful teaching of Mathematics at a community college preferred.

Salary per Board of Trustee approved salary schedule. Starting date: September 12, 1990. A letter of application, resume, college transcripts (unofficial), and three current relevant letters of recommendation must be received by 4:30 pm, May 7, 1990. All application materials become the property of Olympic College. Apply: Bernice Vonnegut, Olympic College Personnel, 16th and Chester, Bremerton, WA 98310-1699. (206) 478-4980. Equal Opportunity Employer.

GREECE

UNIVERSITY OF CRETE, GREECE Department of Mathematics

Permanent and visiting positions at all levels and areas of Mathematics are available. Expressions of interest are invited from mathematicians holding the Ph.D. degree. (Greek citizenship is required by law, for the permanent positions. Knowledge of Greek is required in both cases, except for a very restricted number of visiting positions.) Write to Prof. Susanna Papadopoulou, Chairperson, Mathematics Department, University of Crete, Iraklion, Greece, including vita and representative research work.

TAIWAN

NATIONAL CHUNG-HSING UNIVERSITY Department of Applied Mathematics Taichung, Taiwan

The Department of Applied Mathematics seeks applicants for 5-6 positions at Professor or Associate professor level in numerical analysis, differential equations, computer science, statistics or applied mechanics. Competitive salary with good benefits and low tax rate. The department has a Ph.D. program. Write to: Dr. L. Y. Lin, Head, Department of Applied Mathematics, National Chung-Hsing University, Taichung, Taiwan.

UNITED KINGDOM

UNIVERSITY OF WARWICK Research Fellow Mathematics Institute

Applications are invited for one or more SERC funded posts, starting 1 October 1990, to work with the Geometry Group led by Professor D B A Epstein. The Geometry Group consists of pure mathematicians and computer scientists at Warwick University, and is associated with the NSF supported Geometry Supercomputer Project based in Minneapolis. Its objectives are to use computers to understand phenomena in geometry, mainly hyperbolic geometry.

Desired background: Unix, C, hyperbolic geometry, (combinatorial) group theory, basic computer science.

Salary on the RA1A scale: £10458-£16665 pa.

Application forms and further particulars from the Personnel Office, University of Warwick, Coventry CV4 7AL, England (0203 523627). Closing date 22 May 1990. Please quote Ref No 30/3A/89 (please mark clearly on envelope).

AN EQUAL OPPORTUNITIES EMPLOYER

PUBLICATIONS WANTED

Wanted: Mathematical books, journals, reprints, ephemera. Contact R. K. Dennis, Math. Dept., White Hall, Cornell U., Ithaca, NY 14853-7901. Tel: 607-255-4027, FAX: 607-255-7149. e-mail:

dennis@mssun7.msi.cornell.edu

SITUATIONS WANTED

TEACHING MATHEMATICIAN. PH.D. 1982. AGE 38

Speciality: Differential Equations. 5 published articles. 15 years experience in teaching and research in U.S.A. and abroad. Excellent students and peer evaluations of classes. References and résumé available upon request. Available immediately. M. Abbassi, 500 Tulip Rd., State College, PA 16801

ERRATA

In the Positions Available section in the March issue of *Notices*, page 359, the application closing date for the position advertised by the University of Texas at San Antonio was incorrectly published as March 15, 1990. The correct closing date should have been April 1, 1990.



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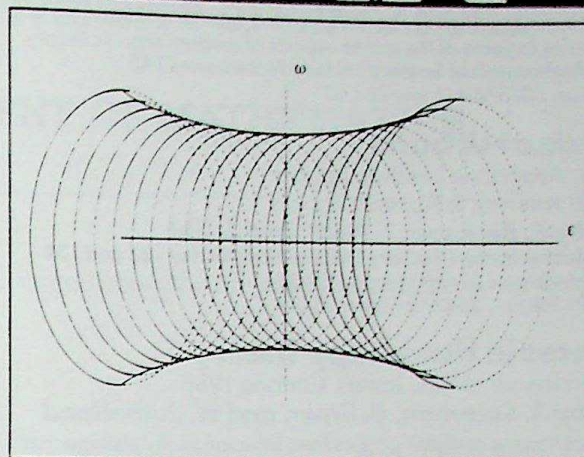
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In the spring of 1985, A. Casson announced an interesting invariant of homology 3-spheres via constructions on representation spaces. This invariant generalizes the Rohlin invariant and gives surprising corollaries in low-dimensional topology. In the fall of that same year, Selman Akbulut and John McCarthy held a seminar on this invariant. These notes grew out of that seminar.

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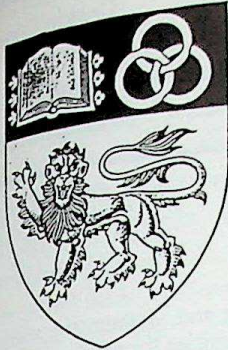
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- ☐ Punjab Mathematical Society
- ☐ Ramanujan Mathematical Society
- ☐ Real Sociedad Matemática Española
- ☐ Sociedad Colombiana de Matemática
- ☐ Sociedad de Matemática de Chile
- ☐ Sociedad Matemática de la Republica Dominicana
- ☐ Sociedad Matemática Mexicana
- ☐ Sociedade Brasileira Matemática
- ☐ Sociedade Brasileira de Matemática Aplicada e Computacional
- ☐ Sociedade Paranaense de Matemática
- ☐ Sociedade Portuguesa de Matemática
- ☐ Societat Catalana de Matemàtiques
- ☐ Société de Mathématiques Appliquées et Industrielles
- ☐ Société Mathématique de Belgique
- ☐ Société Mathématique de France
- ☐ Société Mathématique Suisse
- ☐ Southeast Asian Mathematical Society
- ☐ Suomen Matemaattinen Yhdistys
- ☐ Svenska Matematikersamfundet
- ☐ Union Matemática Argentina
- ☐ Unione Matematica Italiana
- ☐ Vijnana Parishad of India
- ☐ Wiskundig Genootschap

Letters to the Editor

Graduate Student Support

Everyone knows "what the graduate students should do for us". How about "what can we do for the graduate students"? Contrary to common belief, there are many graduate students in Mathematics who support families, continue paying rent during summer, eat three times a day, and visit their families once a year. More emphasis on teaching? This semester, I am teaching two undergraduate courses (at another university) in addition to my duties in my own department: four courses and several seminars that I try to attend, not mentioning my thesis. Some of us need *unconditional* financial support, summer support, medical and dental insurance, and daycare for children more than "emphasis on teaching". My greatest fantasy is teaching only one course per semester *and* having a grader.

Füsun Akman
Yale University

(Received March 20, 1990)

Quick Publication of Short Papers

Robert S. Strichartz made interesting proposals in the March *Notices* on Revamping and Revitalizing the Abstracts.

It may be interesting to note that there exists a journal in North America working along the lines proposed by Dr. Strichartz: The C.R. Mathematical Reports of the Academy of Science (Royal Society of Canada). Its stated purpose "is to provide quick publication of short papers summarizing completed research". It allows papers of up to six pages. Accordingly, both precise statements and their motivation and explanation may be included. Except when the proofs are so short that their essence can be incorporated in the paper, a

detailed version ("preprint") has to be submitted (not for publication) with the short paper and both are refereed.

Most of this seems to be in line with what Dr. Strichartz proposes and the American Mathematical Society may wish to consider publishing a similar journal. For the purpose of fast publication and because of lack of money, Math. Reports photoreproduces the papers from manuscript. Almost everybody would prefer computer typesetting and proofreading, even if this slows down the publication somewhat. There can also be problems with the balance of topics and even with quality. Lately some doubts have been expressed as to whether a journal of this kind is needed. The reaction of many Canadian mathematicians and Dr. Strichartz's letter seem to show that it is.

Professor George Duff (University of Toronto) is editor-in-chief of Math. Reports but papers may be submitted to any fellow in Mathematics of the Royal Society of Canada. They are listed in every issue of the journal. So are instructions for preparation of manuscripts.

János Aczél

University of Waterloo
(Received March 30, 1990)

Masculine/Feminine Dichotomy

I should like to say how much I deplore the dichotomy between "masculine" and "feminine" which appears in your columns in relation to mathematics, and to question whether remark (3) in the letter of Vera Huber-Dyson in Vol. 37, No. 2 viz: 'To be sure a woman in Mathematics has to face additional obstacles from her colleagues as well as from the outside world,' is true.

This was not so in my case. I was *encouraged* as a student by G. H. Hardy and E. C. Titchmarsh and later positively pushed on to important committees, and into being Chairman of this and that by

colleagues, mathematicians and others. I usually found myself the only woman in mathematical assemblies. One woman who started ahead of me was overwhelmed by teaching, a fate to which men also succumb.

I should also like to record that I did not *choose* to do mathematics, and at the age of about 13 positively disliked some of the mathematics then taught. Later, just before going to Oxford, I was told that Mathematics was my best subject by a remarkable woman, Miss E. M. Hancock. To the best of my knowledge she had obtained an External London degree by teaching herself out of tutorial books designed for such people. I believe she had to look after an aged relative and when that relative died Miss Hancock went to teach at Yeng Ching Women's University in

Policy on Letters to the Editor

Letters submitted for publication in *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule normally requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of *Notices* in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made. Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of *Notices* should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in *Bulletin of the American Mathematical Society* will be considered for publication. All published letters must include the name of the author.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of *Notices*, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, and will be acknowledged on receipt.

what was then Peking. I estimate that she was a better mathematician than many University Professors then and now. Why aren't there more women like her?

My own impression is that comparatively few women ever have suf-

ficient contact with *good* mathematicians so that perhaps many who could do well never find out what good mathematics is like. Further, the emphasis in the U.S.A. on women in mathematics is probably building up a wave of opposition. Teach *good*

mathematics as widely as possible and *encourage* outstanding talent in men and women, but don't differentiate.

Dame Mary L. Cartwright, F.R.S.
Cambridge, England
(Received March 21, 1990)

NOMINATIONS FOR THE 1991 SATTER PRIZE

In 1990, the American Mathematical Society established the Ruth Lyttle Satter Prize in Mathematics (see the News and Announcements section of this issue of *Notices*). The Satter Prize is to be awarded in odd-numbered years and will recognize an outstanding contribution to mathematics research by a woman in the previous five years. The first Satter Prize will be awarded at the Joint Mathematics Meetings in San Francisco in January, 1991.

The Committee to Select the Winner of the Satter Prize for 1991 (Joan Birman, Columbia University; Linda Keen, Herbert H. Lehman College of the City University of New York (chair); and Karen Uhlenbeck, University of Texas at Austin) is seeking nominations and suggestions from members of the mathematical community.

Nominations should include the candidate's name, affiliation, field of research, and a description of the work for which the prize would be awarded. This material should be sent to

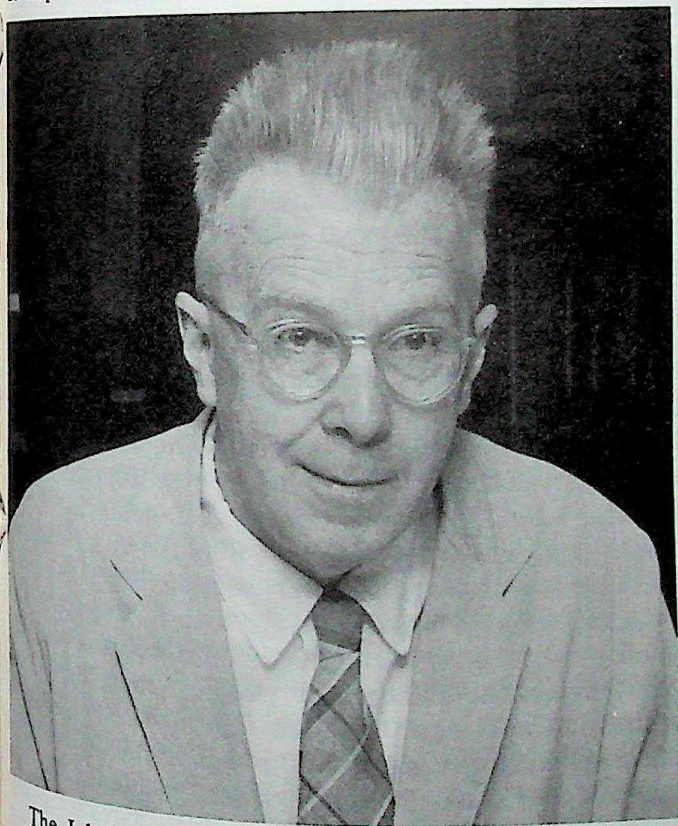
Robert M. Fossum, Secretary of the AMS,
Department of Mathematics, University of Illinois, 1409 W. Green Street, Urbana, IL 61801

*Nominations must be received by **September 30, 1990.***

Otto Neugebauer

1899–1990

Otto Neugebauer (26 May 1899 – 19 February 1990) was an eminent historian of ancient and mediaeval mathematics and astronomy. However, readers of *Notices* will be most interested in his role in the creation and development of *Mathematical Reviews* (MR).



The *Jahrbuch über die Fortschritte der Mathematik* was founded in 1871; it undertook to publish a single volume containing reviews of all the mathematics published in a given year. By the 1920s the *Jahrbuch* was failing to cope with the information explosion in mathematics, which was then amounting to some 2000 articles a year (less than what *Mathematical Reviews* publishes each month nowadays!) It was Neugebauer who persuaded Springer-Verlag to add mathematics to its abstracting journals in other sciences, with the plan of reviewing articles as rapidly as possible, without regard to their sequence; the first issue of the *Zentralblatt für Mathematik* appeared in 1931, with Neugebauer as editor. It

rapidly became an essential reference for every working mathematician. Neugebauer opposed the Nazis and was forced out of his academic position in Göttingen. In 1933 he emigrated to Denmark, and in 1934 became a Professor of Mathematics there, continuing to edit the *Zentralblatt* until 1938, when Springer-Verlag, under pressure from the German government, asked him to edit it in accordance with Nazi principles. This led to his resignation (along with most of his editorial board), and he destroyed his files.

It had become clear that the mathematical community could no longer function without a reliable abstracting service, and *Mathematical Reviews* was established in Providence, where Neugebauer had become Professor of Mathematics in 1939 (he was to become Professor of the History of Mathematics in 1947) at Brown University. The original editorial board of MR consisted of Neugebauer, Tamarkin and Veblen, but most of the actual work was done by Neugebauer himself; soon, however, there was an assistant editor; and, from 1945 onward, a full-time executive editor. The character of MR was established by Neugebauer. Originally the languages for reviews were English, French, German and Italian, the languages of the International Congress. However, letters from MR were always written in English (as Neugebauer explained on one occasion, because English was the language of his secretary). Neugebauer always insisted that the length of the review was not intended to be directly proportional to the importance of the paper; indeed, a bad paper needed to have a review sufficiently detailed so that nobody needed to look at the paper itself, whereas a really important paper needed only to be called to the world's attention.

Over the years, Neugebauer received many awards, but the one that gave him the most pleasure, he said, was the Award for Distinguished Service to Mathematics, from the Mathematical Association of America, presented to him in 1979, principally for his founding and editing of the *Zentralblatt* and MR.

R. P. Boas
Northwestern University

Renewing U.S. Mathematics

A Plan for the 1990s

In 1984 the National Research Council's (NRC) Ad Hoc Committee on Resources for the Mathematical Sciences released its report "Renewing U.S. Mathematics: Critical Resource for the Future" (see *Notices* volume 31, pages 141-145, 435-466, 570-616 and volume 30, pages 271-279). This so-called David Report, named after the chair of the Committee, Edward E. David, Jr., recommended a national plan to renew and ensure the health of the U.S. mathematical sciences enterprise. In 1985 the NRC asked Dr. David to chair the Committee on the Mathematical Sciences: Status and Future Directions. This Committee has now released its report, "Renewing U.S. Mathematics: A Plan for the 1990s" (which has already been referred to as David II). It describes developments in the five years since the publication of the original David Report, and recommends actions to address continuing concerns as well as issues which have recently come more clearly into focus.

The Committee received support from the following organizations: Air Force Office of Scientific Research, Army Research Office, Department of Energy, National Science Foundation, National Security Agency, and Office of Naval Research (contract number DMS-8821296). The opinions, findings, conclusions, and recommendations expressed in the Report are those of the authors and do not necessarily represent the views of the supporting organizations.

The Report is being broadly distributed in the federal and higher-education sectors. The Report itself may be purchased from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, DC 20418 (202-334-3313). The Executive Summary is available free of charge from the Board on Mathematical Sciences, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, DC 20418. The Executive Summary and the table of contents of "Renewing U.S. Mathematics: A Plan for the 1990s" are reprinted below, with the permission of the National Research Council.

Renewing U.S. Mathematics—The 1984 Report

In 1981 a committee of the National Research Council was formed to investigate the health of the mathematical sciences [1] in the United States. Its 1984 report, *Renewing U.S. Mathematics: Critical Resource for the*

Future (the "David Report") [2], found that although the field was thriving intellectually, government support had deteriorated to a dangerously low level. Moreover, the number of young people entering the mathematical sciences had decreased to a level inadequate to replenish the field. In particular, the number of productive mathematical scientists was projected to decline sharply in the 1990s when the current generation of senior researchers retires. This decline was expected to have serious consequences for the nation's scientific and engineering research effort because of the fundamental role of mathematics in the exact sciences. Today a shortage of mathematicians takes on added urgency as we recognize mathematics education as a national priority.

The 1984 Report recommended a plan for renewal, the National Plan for Graduate and Postdoctoral Education in the Mathematical Sciences. That plan's essential feature was a call for funding to bring support for the mathematical sciences into balance with support for the physical sciences and engineering. The interdisciplinary committee that wrote the 1984 Report quickly realized that the low level of research support for U.S. mathematical sciences was so severe that it threatened the vitality of the entire scientific enterprise: the enormous disparity in the number of people supported in the mathematical sciences vis-à-vis other sciences and engineering meant that support for the overall science and technology base was in poor balance, thus threatening its effectiveness. Solving the problem of inadequate support for the mathematical sciences was therefore necessary as much to restore a healthy balance to the nation's scientific enterprise as to assure a healthy mathematics research capability. Without attempting to define "ideal" balance, the 1984 Report recommended levels of support for research and researcher training in the mathematical sciences that would eliminate at least the gross imbalance documented there. Their actions in response to the 1984 Report make it clear that the mathematical sciences community and the federal funding agencies have accepted the conclusions that an imbalance existed and needed to be countered.

The Current Report—A Plan for the 1990s

As requested by the National Science Foundation (NSF) and the Interagency Committee for Extramural Mathematics Programs (ICEMAP), this report updates the 1984 Report. Specifically, the charge directed the committee to (1) update that report, describing the infrastructure and support for U.S. mathematical sciences research; (2) assess trends and progress over the intervening five years against the recommendations of the 1984 Report; (3) briefly assess the field scientifically and identify significant opportunities for research, including cross-disciplinary collaboration; and (4) make appropriate recommendations designed to ensure that U.S. mathematical sciences research will meet national needs in coming years.

Of the several components of the mathematical sciences community requiring action, its wellspring—university research departments—is the primary focus of this report [3]. The progress and promise of research—described in the 1984 Report relative to theoretical development, new applications, and the refining and deepening of old applications—have, if anything, increased since 1984, making mathematics research ever more valuable to other sciences and technology.

However, although some progress has been made since 1984 in the support for mathematical sciences research, the goals set in the 1984 Report have not been achieved (Table A). Practically all of the increase in funding has gone into building the infrastructure, which had deteriorated badly by 1984. While graduate and postdoctoral research, computer facilities, and new institutes have benefited from increased resources, some of these areas are still undersupported by the standards of other sciences (Table B). And in the area of research support for individual investigators, almost no progress has been made. A critical shortage of qualified mathematical sciences researchers still looms, held at bay for the moment by a large influx of foreign researchers, an uncertain solution in the longer term.

While government has responded substantially to the 1984 Report's recommendations, particularly in the support of infrastructure, the universities generally have not, so that the academic foundations of the mathematical sciences research enterprise are as shaky now as in 1984. The greatest progress has been made in the mathematical sciences community, whose members have shown a growing awareness of the problems confronting their discipline and increased interest in dealing with the problems, particularly in regard to communication with the public and government agencies and involvement in education.

In addition to being essential to the continued vitality of U.S. science and technology, addressing the problems of the health and renewal of the U.S. mathematical sciences research enterprise offers the added benefit of

contributing directly to solving the critical problems of mathematics education in America. Without the vital nerve center of a healthy and self-renewing research enterprise in university mathematical sciences departments, all the other aspects of our necessary national effort to improve mathematics education will be slowed and inhibited. The need for replenishment of university research faculties is greater and more uncertain in the decade of the 1990s than ever before, and the effects of a deterioration will be felt not only in research production, but also in the educational preparation of scientists and engineers generally, of mathematical scientists and teachers, and of a scientifically and mathematically literate public.

TABLE A. Federal Support of Mathematical Sciences
Research—Progress Over Five Years, 1984–1989

Category of Support	1984 National Plan Goal	1984 Level	1989 Level	Percent Change, 1984 to 1989	Percent of 1984 National Plan Goal Reached by 1989
Number of researchers supported					
Senior Investigators	2600	1800	1900	+6	73
Postdoctoral researchers	400 ^a	132	188 ^b	+42	47
Graduate research assistants	1000	411	661 ^b	+61	66
Total dollars (millions)	225 ^c	99.6 ^d	133	+34	59

^a The 1984 National Plan calls for awarding 200 two-year postdoctorals annually, resulting in a population of 400 at any given time.

^b Most recent counts comparable to the 1984 numbers, from fall 1988. (NSF Division of Science Resources Studies, personal communications.)

^c 1984 National Plan goal adjusted for inflation using Higher Education Price Index; revised National Plan goal is \$250 million.

^d In 1989 dollars, using Higher Education Price Index.

TABLE B. Selected Indicators of Imbalance
in Research Support

	Chemistry	Physics	Mathematical Sciences
Percent of R&D faculty with federal support, 1987	56	75	37
Number of postdoctorals with federal support, 1988	2587	1280	188
Percent of graduate students with research support, 1987	49	51	18

Sources: Faculty percentages from National Research Council, Survey of Doctorate Recipients project (personal communication); other entries from National Science Foundation, Division of Science Resources Studies (personal communication).

Conclusions and Recommendations

I. Implement the 1984 Report's National Plan

Conclusion: Progress has been made in carrying out the 1984 Report's National Plan, but support for the mathematical sciences remains seriously out of balance with that for the other sciences and engineering. The numbers of supported senior investigators, graduate research assistants, and postdoctoral researchers are still seriously out of line with the numbers supported in other sciences of comparable size.

Since 1984 there have been significant increases in support for mathematical sciences graduate students and postdoctoral researchers, but no meaningful increase in the number of senior researchers supported. The numbers of currently supported graduate students and postdoctoral researchers are still far short of the goals set in the 1984 National Plan, and the number of senior researchers supported remains approximately 700 short of the goal.

The National Science Foundation has substantially increased support for the mathematical sciences, as has the Department of Defense, which has established new programs at the Defense Advanced Research Projects Agency and the National Security Agency. The Department of Energy has funded a major effort in computational mathematics. Other government agencies have provided only moral support. The mathematical sciences community has responded actively to the challenges posed in the 1984 National Plan.

Recommendation I: Fully implement the 1984 National Plan while increasing the level of annual federal funding for the mathematical sciences to \$250 million from \$133 million (in 1989 dollars) over the next three years. The 1984 National Plan's goal of \$180 million per year has risen due to inflation to \$225 million, to which is added \$25 million per year for implementing the second thrust of Recommendation II, below.

II. Improve the Mathematical Sciences Career Path

Conclusion: The rate at which young people enter the mathematical sciences remains inadequate to renew the field.

The attrition rate for students in the mathematical sciences is 50% per year, the highest among all scientific fields. The recent report by W.G. Bowen and J.A. Sosa [4] predicts a severe shortage of mathematical and physical scientists for academic positions during the 1990s. Similar shortages are expected for government and industrial positions. This committee believes that bright young people are discouraged from pursuing careers in the mathematical sciences because they find their career prospects are dim. Mathematical sciences departments in universities provide much less opportunity for research,

fewer graduate research assistantships, and far fewer postdoctoral research positions than do other science departments. Students are quick to perceive this.

Corrective action is needed to assure an adequate supply of talented students for the mathematical sciences. Professors must show students that the mathematical sciences offer both intellectual excitement and attractive career prospects. Providing intellectual excitement is the responsibility of the mathematical sciences community. To perceive attractive career prospects, students must see in their own mathematics departments active, successful research enterprises that involve graduate students, young faculty, and senior researchers, all supported at levels competitive with those in other sciences and engineering.

Recommendation II: Improve the career path in the mathematical sciences. Specifically,

- The funding called for in Recommendation I should be used to increase the numbers of senior, junior, and postdoctoral researchers, and graduate research assistants supported. This committee reiterates the 1984 call for annual federal support for 2600 senior investigators, 200 new postdoctoral researchers, 1000 graduate research assistants, and 400 research grants for young investigators [5]. At these levels of support the mathematical sciences would be renewed by an influx of fresh talent, and the nation could realize fully the scientific potential of some 700 first-rate senior researchers who now lack federal support. Finally, funding for the mathematical sciences would be brought into balance with levels of funding for other science and engineering fields. Until the present clear imbalance is countered, students will continue to find the mathematical sciences less attractive than other fields, and renewal of U.S. mathematicians will fail.

- Ten percent of the funding called for in Recommendation I should support coherent programs that directly encourage young people to enter and remain in mathematical sciences careers. Recruitment of women and minorities into the mathematical sciences is a high priority. The NSF and other government agencies should solicit research proposals for programs that will improve the career path. Such proposals may combine research opportunities for students, postdoctorals, and young faculty with increased support for senior researchers who can act as mentors. Proposals may be submitted by whole departments, faculty groups (possibly with members from different departments), or individuals. Special criteria may be required to judge such proposals.
- Academic mathematical sciences departments should give increased recognition to faculty who act as mentors for students and junior colleagues, who contribute to education, and who interact with

collaborators from other disciplines. This change would encourage efforts to improve the teaching of mathematics both at the undergraduate and graduate levels.

• Universities should do more to strengthen their mathematical sciences departments. Universities should give these departments adequate resources to meet the responsibility of preparing large numbers of science and engineering students while also providing adequate resources for research training in the mathematical sciences.

III. Support a Sufficient Number of Individual Investigators

Conclusion: Mathematical sciences research has been extraordinarily productive over the past five years.

Striking progress has been made along a broad front, from the most abstract branches of core mathematics to computer algorithms for the most practical problems. Appendix B of this report documents some of the main trends. As remarkable as recent mathematical research has been, a substantially greater rate of progress is possible because the mathematical sciences enterprise is running well below its attainable productivity. Most mathematical sciences research is done by some 2600 highly active investigators—a conservative estimate [6]—of whom about 700 are entirely unsupported by federal funds. A substantial fraction of these 700 lack even the two months of uninterrupted research time provided by typical grants. Because these mathematical scientists are highly productive, small investments in support can produce large payoffs in the form of major advances. Since the mathematical sciences have so strong an impact on science and technology, this opportunity should not be wasted.

Recommendation III: Increase to 2600 the number of mathematical sciences senior investigators supported annually. As explained in Conclusion II, this is also a basic step to meeting the problems of renewal. It is the one funding recommendation in the 1984 National Plan on which no meaningful action has been taken. The time has come to take full advantage of the remarkable scientific opportunities offered by the mathematical sciences.

These overarching recommendations suggest particular actions—by federal agencies, universities, department chairs and university administrators, and the mathematical sciences community—that are specified in Chapter 5 of the full report.

Underpinning these recommendations, and adding urgency to them, is the belief held by the committee that a vigorous mathematical sciences research enterprise is crucially important to the task of upgrading mathematics

instruction in our primary and secondary schools and at the collegiate level. As Morris Tanenbaum, vice-chairman of AT&T and a member of this committee, expressed it:

Everything you read about our children's education makes you weep because so many of them can't add, subtract, or understand a simple formula. Everything you read says that many of their TEACHERS can't teach them those simple, necessary skills. You ask: "Where do the teachers come from?" The teachers come from undergraduate schools, where they haven't had any significant education in mathematics. Then you ask: "Who teaches the teachers? Who will really teach them from a first-rate point of view?" Their professors must come from good schools that attract and educate people who are truly interested in mathematics. All the information we've seen tells us that the community that produces professors in the mathematical sciences is threatened, and weak, and should be rebuilt.

Mathematics plays an essential role at all levels of the educational process, particularly in science and engineering. We must have excellence at the top to have excellence down the line. Research mathematicians train graduate students who go on to teach in the nation's colleges. Mathematics researchers receive their training from active researchers in university research departments. So, too, do most college teachers, whether they become researchers or not. U.S. postsecondary mathematics education and mathematics research are interdependent, and the university department is their nexus. College teachers in turn train the next generation of primary and secondary school mathematics teachers. This process is producing too few teachers who are qualified to teach mathematics. Yet it is at the primary and secondary school levels that students often decide that they can or cannot undertake careers in science or engineering. Today mathematics is too often a barrier that discourages students from making ambitious career choices. This is particularly true for minority and women students. Major initiatives in mathematics of the kind recommended in this report thus play a crucial role in strengthening mathematics education at all levels and hence in assuring that the United States will be internationally competitive. Indeed, the committee believes that the health and vigor of the mathematical sciences is a vital index in judging the prospects for national attempts to solve the science-based problems of U.S. society.

Notes

[1] The discipline known as the mathematical sciences encompasses core (or pure) and applied mathematics, plus statistics and operations research, and extends to highly mathematical areas of other fields such as theoretical computer science. The theoretical branches of many other fields—for instance, biology, ecology, engineering, economics—merge seamlessly with the mathematical sciences.

[2] National Research Council, *Renewing U.S. Mathematics: Critical Resource for the Future* (National Academy Press, Washington, D.C., 1984).

[3] Additional reports on critical issues in the mathematical sciences are forthcoming from the Mathematical Sciences in the Year 2000 Committee, whose final report late in 1990 will detail many crucial recruitment and education reforms needed into the twenty-first century.

[4] Bowen, W. G., and Sosa, J. A., *Prospects for Faculty in the Arts & Sciences* (Princeton University Press, Princeton, N.J., 1989).

[5] These goals, developed in the 1984 Report, pp. 57–65, were examined by the committee and found to be still valid today.

[6] National Research Council, *Renewing U.S. Mathematics*, 1984, pp. 61–64.

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Japanese Translation Program

The American Mathematical Society has embarked on a translation project from Japanese under the direction of a Committee consisting of Professor Katsumi Nomizu, Brown University, and Professor Shoshichi Kobayashi, University of California, Berkeley, with a dozen Japanese mathematicians both in the United States and Japan as advisors.

The project will translate Ronsetsu (survey articles) that appear in the official organ *Sugaku* of the Mathematical Society of Japan and publish them in *Sugaku Expositions* on a regular basis. Two volumes (four issues) have appeared already. The project also aims at translating a selection of outstanding monographs in mathematics both at the research and graduate levels that are published in Japan.

Continuing the project will require the services of a number of translators, to cover the various branches of mathematics with the necessary expertise. If you would or might be interested in engaging in such an endeavor, please write Ms. Mary C. Lane, Director of Publication, at the AMS headquarters:

American Mathematical Society
PO Box 6248
Providence, RI 02940 USA
Internet: MCL@MATH.AMS.COM

The Society pays for this work, and you may establish various conditions such as an upper bound on the number of pages per month or per item that you wish to receive, and you may of course return any item not lying within your own area of interest.

The mathematical community will be indebted to everyone who assists in this undertaking.

A Challenge of Numbers:

People in the Mathematical Sciences

In January 1989, the National Research Council (NRC) released a major authoritative report, "Everybody Counts: A Report to the Nation on the Future of Mathematics Education" (see *Notices*, March 1989, pages 227-236). Prepared by the Committee on the Mathematical Sciences in the Year 2000 (MS2000), under the direction of the Mathematical Sciences Education Board and the Board on Mathematical Sciences, this report charted an agenda for change over the next two decades.

The Committee received support from the National Science Foundation and the National Security Agency. The opinions, findings, conclusions, and recommendations expressed in the Report are those of the authors and do not necessarily represent the views of the supporting organizations.

What follows is the Executive Summary of the first of three reports to be released by Project MS2000 prior to the issuance of its final recommendations in late 1990. Entitled "A Challenge of Numbers: People in the Mathematical Sciences", the report itself contains a comprehensive set of data describing the demographic situation in the mathematical sciences and will serve as a valuable reference for educators and administrators in industry and government. The Executive Summary, prepared by Bernard L. Madison (University of Arkansas and former Project Director for the Committee on MS2000), is not a condensation of the full report but rather focuses on some of the important issues that arise from the data.

The Executive Summary is a copyright (1990) of the National Academy of Sciences, National Academy Press, Washington, DC, and is reprinted with permission. *Notices* readers are urged to obtain copies of the full report from the National Academy Press, 2101 Constitution Avenue, Washington, DC 20418; telephone 202-334-3313. The price is \$9.95 per copy (prepaid). A limited number of copies of the Executive Summary are available. Single copies of the Summary may be obtained from the MS2000 Office, National Research Council, NAS 301, 2101 Constitution Avenue, Washington, DC 20418.

Mathematics has long been recognized for fundamental contributions to advances in science and technology and as intrinsic to the education of people who will work in scientifically oriented occupations. In recent

years the applications of mathematics have become more numerous, direct, complex, and essential in many jobs, as well as in everyday life. The increasing use of mathematics in the workplace has produced the need for more workers with a knowledge of college-level mathematics. At the same time demographic trends point to serious shortfalls of mathematically prepared workers and qualified school and collegiate faculty members to train them. The growing need for mathematical skills and the effects of pressures on college and university mathematical sciences* over the past three decades have led many educators and policymakers to conclude that the current system is not responding effectively. ***Thus unless changes occur, the nation's needs for mathematically skilled teachers, scientists, engineers, and hosts of other workers for business, industry, and government will not be met.*** "A Challenge of Numbers" chronicles the conflict between projected need and projected supply. By the year 2000, the U.S. economy is expected to create more than 21 million new jobs, most of which will require both postsecondary education and the use of mathematics (Figure 1 - See next page). Adaptability, problem-solving ability, and numerical reasoning will be critical skills. Eight of the ten fastest growing jobs will be science-based occupations by 1995. Educating sufficient numbers of workers for these occupations will strain the U.S. educational system.

The projected increase in demand for all scientists, engineers, and technicians between 1986 and 2000 is 36%, nearly twice the increase projected for overall employment demands. Many of the fastest growing fields will require workers with extensive mathematical backgrounds.

While the need for technologically trained workers is increasing, the prospective supply is shrinking. The college-age population is shrinking; by 1995 it will be

*Most people accept the meaning of mathematical sciences as mathematics, applied mathematics, and statistics. That meaning is suitable for reading this report, but a broader definition is generally used in the taxonomy of scientific disciplines. Although computer science has in the past been considered part of the mathematical sciences, that is no longer the case.

about 22% below its peak in 1981. The problem is more acute in that white males now dominate the science and engineering work force, but their numbers will decrease by 34% for the college-age group over the same period.

Blacks and Hispanics, both growing portions of the college-bound population, have participated to a lesser degree in mathematics-based areas than have their white male peers. Meeting the increasing need with fewer students and also a greater proportion who have shown a lower interest in mathematics poses a major challenge to the nation's educational system, particularly to the mathematical sciences component.

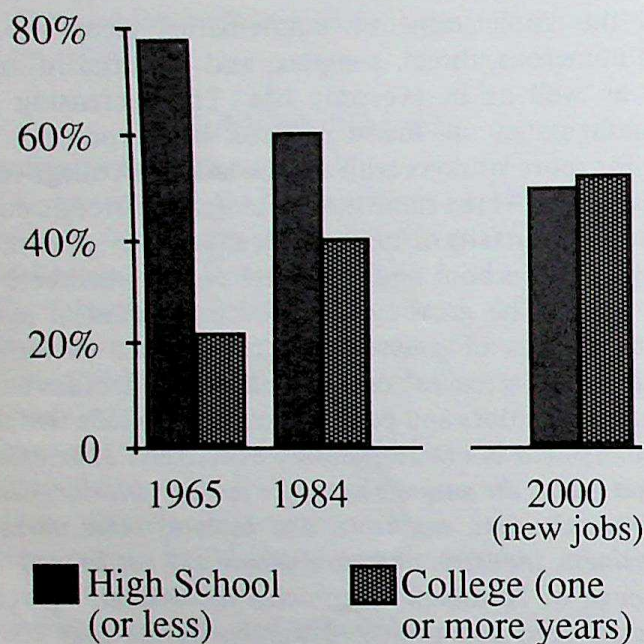


Figure 1. The educational requirements of the work force are increasing.

The mathematical sciences, like other disciplines, experienced an increase in degree production at all levels during the 1960s, which was followed by a decrease in the 1970s. However, in comparison with other disciplines, recovery during the 1980s has been slow. Current trends do not project the recovery to be sufficient to meet expected demands for mathematically skilled workers in the future.

At a time when the precollege educational system is in need of revitalization and revolutionary change, our colleges and universities are not producing school mathematics teachers in sufficient numbers to meet current demands. The most striking challenge is the one faced by the profession to educate itself and to renew its human resources. The current level of Ph.D. production in the mathematical sciences is not sufficient to respond to the future need to replace the now aging faculty. The situation is made more acute by the instability created by the large number of Ph.D. degrees received by non-U.S. citizens.

"A Challenge of Numbers" focuses on students and teachers, who they are, what they learn and teach, how they use what they learn, and the system in which they work. That system is vast and diverse. The mathematical sciences faculty in the 2,500 U.S. colleges and universities constitute about 5.5% of the total collegiate faculty, but they are responsible for nearly 10% of all collegiate teaching and nearly 30% of all collegiate teaching in the natural sciences and engineering. Yet less than 1% of the 3 million students they teach are mathematics majors. This report concerns all students who study mathematics, not just mathematics majors. The majors, however, have a double role to play, as products of the system and more importantly, as the source of the teachers and researchers necessary to renew and sustain the system.

High School to College: A Difficult Transition

The variations in background and motivation among beginning college students are greater in mathematics than in any other discipline. Initial placement in college mathematics courses is complex and difficult because many institutions have more than a half-dozen entry courses, ranging from arithmetic through calculus. *The best entering students are excellent; the weakest have difficulty with elementary arithmetic.* The transition from high school to college mathematics is one of the most troublesome in education. The difficult transition contributes significantly to attrition from the general education pipeline and especially to the attrition from the science and engineering pipeline.

Enrollment patterns indicate that most entering students are not mathematically prepared for college-level courses. Colleges have adapted by offering more elementary courses but have been generally unsuccessful in preparing students for advanced mathematics courses. Over the past 20 years, collegiate mathematics enrollments have doubled, but the major increases have been in the lower-level courses, those below calculus (Figure 2 - See next page). Enrollments in remedial courses, high-school-level courses in arithmetic, algebra, and geometry have led the way, tripling since 1965. Approximately two-thirds of college mathematics course enrollments are in courses below the level of calculus, that is, in courses similar to those taught in high school.

Improving precollege mathematics education will be hampered by a continuing shortage of qualified teachers. Shortages exist and are projected to worsen, but definitive information about this critical work force is scarce. At the time when interest in mathematics as a career was falling, so also was the interest in education as a career. This double decline has drastically reduced the number of college students preparing for school mathematics teaching. In the past few years both declines seem to have abated, but current trends indicate supplies for

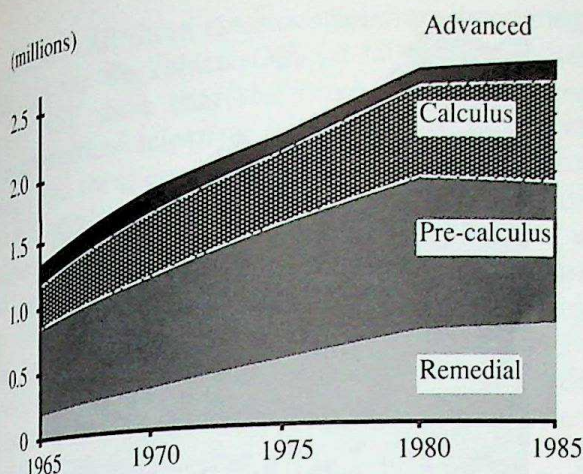


Figure 2. Total undergraduate enrollments in mathematical sciences departments.

below those required to provide quality education at the precollege level.

Declining Numbers of Degrees Awarded

The popularity of mathematics as an undergraduate major has declined dramatically in the past 20 years. The numbers of U.S. students receiving bachelor's, master's, and doctoral degrees in the mathematical sciences were lower in 1986 than they were in 1966. And college enrollments approximately doubled during that period. Part of the decline is likely due to students choosing other mathematically oriented areas, particularly computer science; and part of the decline may be due to the shift of interest away from science and engineering. The decline in interest has been present at all points of the educational pipeline from the ninth grade onward but is most vividly displayed in the fraction of entering college students expecting to major in mathematics, now about one-sixth of what it was in the mid-1960s (Figure 3).

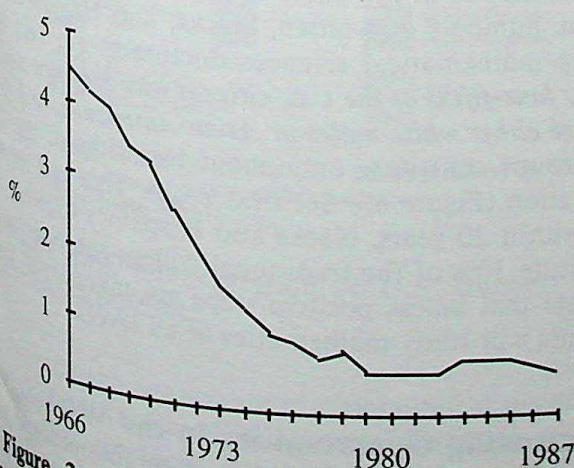


Figure 3. Percentage of entering college students expecting to major in mathematics.

Paralleling those for other areas of science and engineering, the numbers of mathematical sciences bachelor's, master's, and doctoral degrees awarded annually increased steeply during the 1960s, decreased during the 1970s, and recovered somewhat during the 1980s. But the recovery in mathematics has been the slowest of all. For example, in 1975 the number of mathematics doctorates awarded was 65% of the number of chemistry doctorates awarded. By 1985 this figure had dropped to 37%. Mathematical sciences degree production is now at about the levels of the mid-1960s, about 15,000 bachelor's, 3,000 master's, and 800 doctorates each year, levels generally considered too low to meet the demands of the near future (Figure 4 - See next page). The recovery at the baccalaureate level in recent years is apparently due to students switching to the study of mathematics after entering college. This switching and similar patterns of changes in the numbers of degrees awarded at the three levels imply that undergraduate and graduate programs are tightly interconnected and simultaneously subject to the same forces.

Graduate programs in U.S. universities now depend heavily on non-U.S. students. *The fraction of non-U.S. students in mathematical sciences graduate programs has risen from one-fifth in the early 1970s to nearly one-half at the close of the 1980s* (Figure 5 - See next page). This large influx of non-U.S. students into both master's and doctoral programs has not been enough to compensate for the very small number of U.S. students proceeding from one degree level to the next.

Participation of Minorities and Women

The number of students obtaining advanced degrees is lower for the mathematical sciences than among all the other sciences, indicative of the high attrition of U.S. students from the mathematical sciences pipeline. From entry into the ninth grade through receipt of the doctoral degree, a reduction by one-half per year of the number of students enrolled gives curiously accurate estimates of the numbers of students proceeding toward degrees. Thus an enrollment of about 3.6 million ninth graders diminishes to only about 400 U.S. doctorates awarded 14 years later, although this decline is probably not uniform from year to year and is definitely not uniform in its impact on various subgroups.

At all levels, relatively few blacks and Hispanics study or practice mathematics. Their attrition from the mathematics-based careers pipeline is higher than that for all students at all points, and that attrition is severe in the transition from high school to college mathematics. Longitudinal studies of students in the natural sciences and engineering pipeline have shown losses of three of four blacks and seven of eight Hispanics between the

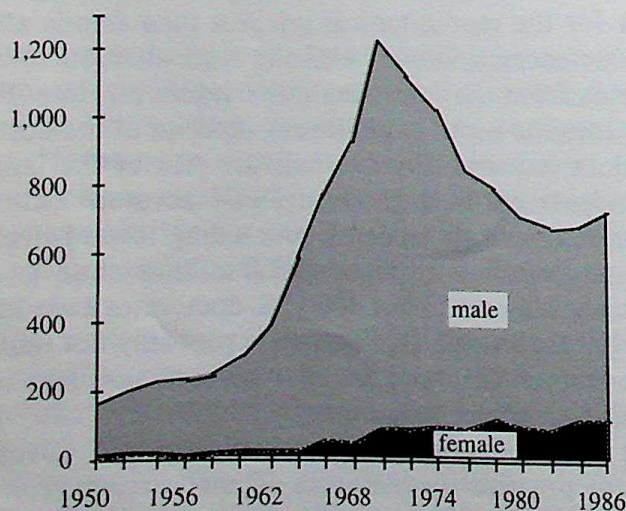
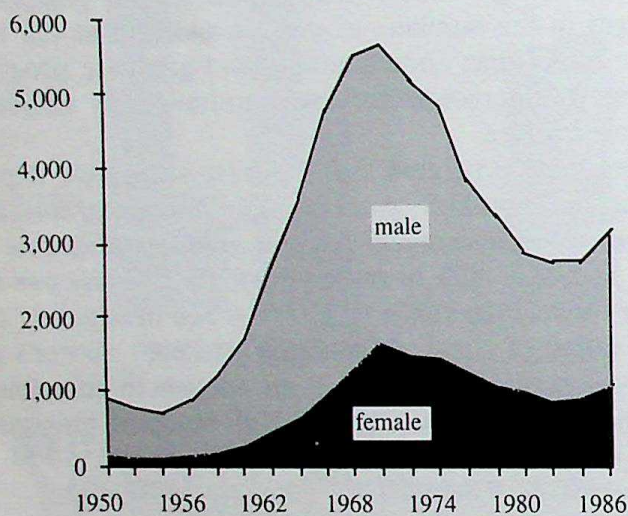
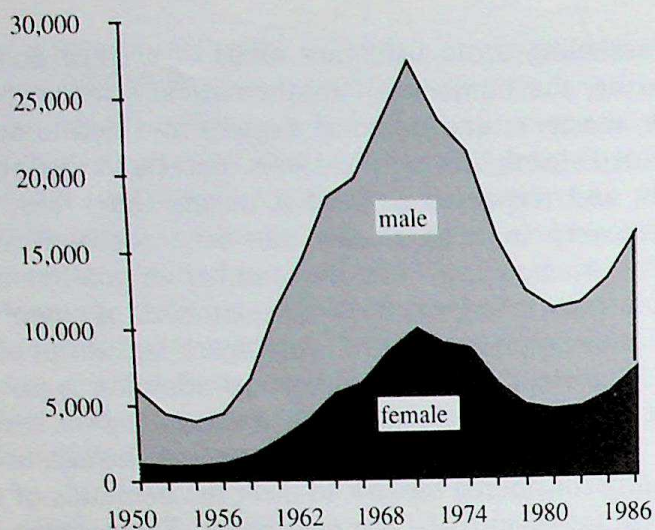


Figure 4. Number of mathematical sciences degrees awarded by U.S. institutions, 1950 to 1986. Top: bachelor's degrees. Middle: master's degrees. Bottom: doctoral degrees.

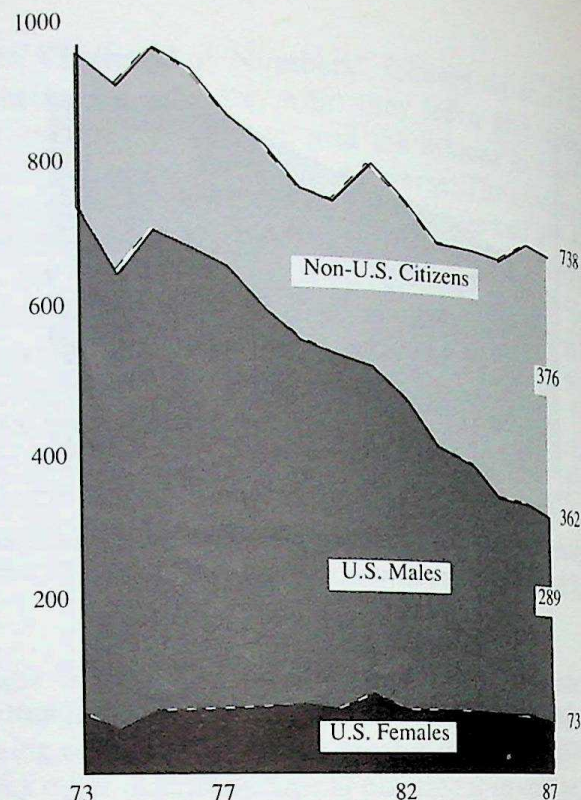


Figure 5. Ph.D. degrees awarded in mathematics.

twelfth grade and the second year of college as compared to an overall rate of two of three.

The share of women in the mathematical sciences is also not reflective of their share of the U.S. population, but the pattern is different from that for blacks and Hispanics. In recent years, at the undergraduate level, the participation of women in the study of mathematics has improved significantly. For example, men and women are now receiving bachelor's degrees in mathematics in nearly equal numbers. But the percentage of women receiving degrees falls off at the master's level, and dramatically so at the doctoral level.

The numbers of women, blacks, and Hispanics who receive mathematical sciences doctorates are very low. *Nearly four-fifths of the U.S. citizens who earn new doctorates are either white males or Asian-Americans*, and these two groups constitute only about two-fifths of the U.S. population (Figure 6 – See next page). This and the fact that within 20 years, blacks and Hispanics together will constitute 30% of the traditional college-age population indicate that unless positive steps are taken even fewer students will study mathematics at all levels.

Increasing Opportunities in the Workplace

Although mathematics long has been the underpinning of science and technology, mathematics has not been widely recognized as a profession except in academic applied mathematics and statistics have somewhat wider

recognition. All three classifications are becoming more visible in the workplace. Official labor data as reported by the NSF show that *the number of persons employed as mathematical scientists has almost tripled in the past decade*, and these counts do not include most mathematics teachers. Further, over the same period, the demand for employment of mathematical scientists in science and engineering areas has increased dramatically, so that now four of five nonacademic mathematical scientists work in science and engineering (Figure 7). For the period 1986 to 2000, the projected increase in demand for mathematical scientists is 29%, compared to a 19% overall increase in employment demands.

mathematics faculty members have been high and are expected to increase over the next several years. Overall, approximately one-fourth of bachelor's degree holders, one-third of master's degree holders, and three-fourths of doctoral degree holders in the mathematical sciences begin work in education.

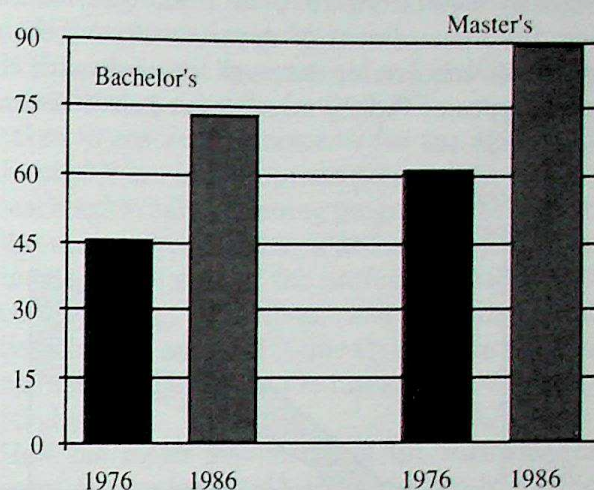
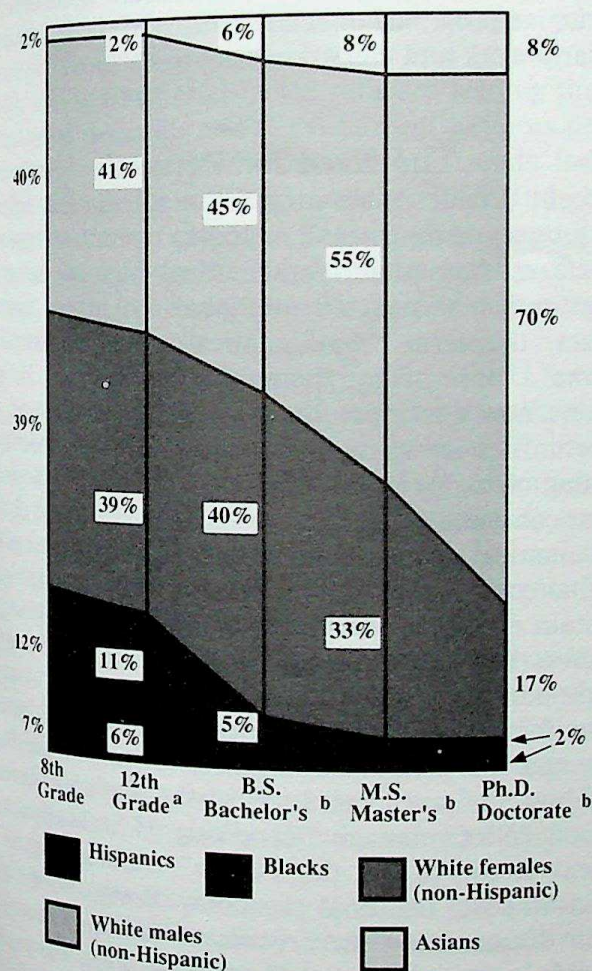


Figure 7. Percent of recent mathematics degree holders employed in a science or engineering job, 1976 and 1986.

Over the past 40 years, approximately 525,000 persons have received U.S. bachelor's degrees, 110,000 have received master's degrees, and 24,000 have received doctorates in the mathematical sciences, but official counts of employed mathematical scientists include only about one-fourth of the total of 525,000. Many of these degree holders are employed in a variety of areas throughout the work force, and detailed information about current or future needs for replacements is not available. Outside academe, lack of information about what degree holders do now and what their potential contributions are dulls the appeal of mathematics as a major and as a profession. Within academe, mathematical scientists in the workplace are more visible, since mathematical science departments usually have a strong presence on campus.

Uncertain Stability and Renewal of the Faculty

The need for mathematical sciences programs to accommodate students from more diverse backgrounds and to educate more people to higher levels of proficiency has been met with a mixture of faculties and methods of teaching. The number of part-time faculty members has soared, tripling from 1970 to 1985 and accounting for the majority of persons on the faculty in two-year colleges. Part-time faculty members, graduate teaching assistants, and temporary full-time faculty members constitute approximately one-fourth of the full-time equivalents on the nation's collegiate mathematics



^aHigh school record indicates possible choice of mathematics as a college major.
^bDegrees in mathematics.

Figure 6. A representation of U.S. students in the mathematics pipeline.

Even though nonacademic mathematical sciences employment has increased, educational institutions are still a principal employer, especially for doctorate mathematicians, creating a close tie between the health of the mathematical sciences and the health of education. Demands for school mathematics teachers and for college

faculty and carry a large share of the teaching in many departments. Especially during the 1970s, student enrollments increased significantly, while the number of full-time faculty members remained flat. Student-faculty ratios increased, especially in the research universities, where the number of full-time faculty members actually decreased by 14% from 1970 to 1985. The nature of teaching, the management of departments, and the role of traditional scholarship have all changed with these changes in types of faculty members and their duties.

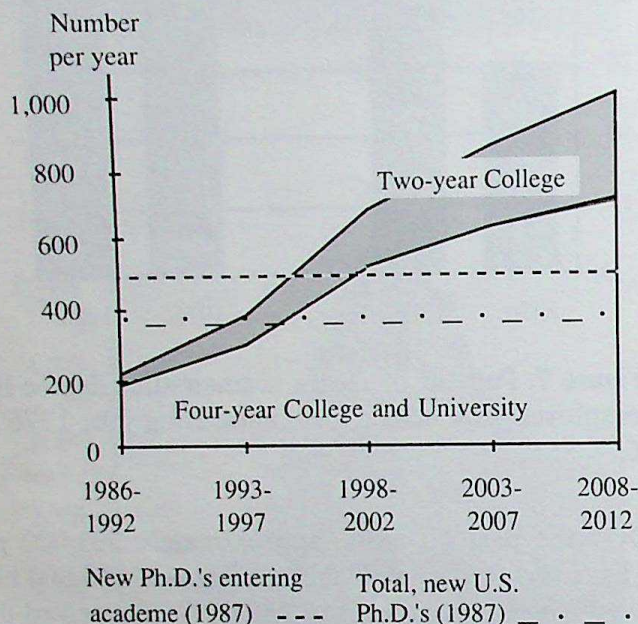


Figure 8. Estimated number of retirements of full-time college and university mathematical sciences faculty.

The employment market for the full-time collegiate mathematical sciences faculty members is not very responsive to the usual laws of supply and demand. This faculty has few members, about 25,000, but their responsibilities are critical to the nation's efforts in science and engineering. There is no significant reserve supply of fully qualified candidates for faculty positions. Balancing supply and demand is difficult because of long response times. There have been mild shortages of faculty candidates since the early 1980s and more severe shortages are likely by the year 2000. *By then, the current number of new doctoral degree holders taking academic positions in the United States will not even be sufficient to replace faculty lost to retirement, much less to replace those that leave academe or to accommodate any increased demand* (Figure 8). *All this means continued heavy reliance on non-U.S. citizens.* Almost all scenarios for reform of mathematics education would certainly exacerbate these shortages, and the likely increased demand for bachelor's and master's degree holders in business and industry will, at least in the short run, further increase the demand for faculty

while simultaneously reducing the supply.

The U.S. mathematical sciences research community is the strongest in the world, and the graduate education of the best students is excellent. But there are signs of stress and weakening. Of full-time faculty members, about one-third are considered to be active researchers, about one-third the remaining two-thirds have no program of scholarly renewal, which creates a greater likelihood of losing intellectual growth and enthusiasm as time goes by. Research in mathematics is traditionally defined as producing new mathematical results for publication in journals. This definition and the lack of alternative activities that are present in more applied areas have contributed to both the small fraction of faculty members considered to have active programs of scholarship and the gap between scholarly work and classroom lectures.

The Need for Renewal

In recent decades, new areas of mathematical sciences have grown and flourished, including operations research, discrete mathematics, mathematical biology, statistical design and analysis, and nonlinear dynamical systems. In fact, the term "mathematical sciences" itself has become a part of the taxonomy of science. In spite of these new developments, new applications, and new opportunities for using technological advancements, the teaching of mathematics has responded little. Both curricular content and its delivery have been slow to change. Mathematical sciences departments have not been able to simultaneously cope with enormous instructional loads, maintain excellence in faculty scholarship, and allocate resources to innovations. The forces at work are too diverse and too disparate.

By the early 1980s the need for renewal became clear, and the mathematical sciences community began to address the problems. In 1984 the National Research Council (NRC) issued "Renewing U.S. Mathematics: Critical Resource for the Future" (referred to as the David Report; National Academy Press, Washington, D.C.), documenting the erosion of federal support for research in the mathematical sciences. This was the first of a series of efforts within the NRC and in professional societies to assess the health of the mathematical sciences and to design a plan for renewal.

The NRC project Mathematical Sciences in the Year 2000 (MS 2000), of which this report is a part, was initiated in 1986 as *an effort to assess the state of college and university mathematics and to design a national agenda for revitalization and renewal.* As a major first step, "Everybody Counts" (National Academy Press, Washington, D.C., 1989), produced by the MS 2000 Committee together with the Mathematical Sciences Education Board and the Board on Mathematical Sciences, outlined the issues concerning mathematics education at all levels

"A Challenge of Numbers", the first descriptive report of the MS 2000 Committee, provides a profile of the people associated with college and university mathematical sciences. Two additional descriptive reports are forthcoming, one on curriculum and one on support resources. These three reports will form a basis for the final report of the MS 2000 Committee, which will contain recommendations for actions to achieve revitalization and renewal of the mathematical sciences in colleges and universities.

Issues and Implications

The challenge of numbers emerges from two general facts: (1) the workplace has changed because jobs increasingly require higher-level skills and greater adaptability, and mathematics-based jobs are leading the way in increased demand; and (2) if current patterns persist, most socioeconomic and demographic trends indicate that fewer students will study mathematics and choose mathematics-based careers. These trends point to an increased demand for and a shrinking supply of mathematical scientists and other mathematically educated workers.

This dilemma poses a major challenge for U.S. education in general and college and university mathematical sciences in particular. Educating workers for business and industry and teachers for all levels of education may require fundamental changes in a system already stressed by the events of the past three decades. Several issues that require the nation's attention are apparent. These are raised by the following questions:

- **How can national needs for mathematically educated workers be met?** How can the expected shortage of mathematically trained workers be averted? How can available workers be better utilized? What incentives will attract more interest in mathematics-based occupations, especially among women, blacks, and Hispanics?
- **What changes are necessary to attract more students to the study of mathematics?** How can the mathematical sciences respond to the change in the traditional pool of U.S. college students? What and who will stimulate students to study the mathematical sciences? How can the heavy dependence on white males be reduced? What are the consequences of heavy dependence on non-U.S. students in graduate programs? How can teaching become more effective and stimulating?
- **What can be done to improve the success rate of students during the transition from high school mathematics to college mathematics?** How can high school preparation and college expectations be better reconciled? What effects are remedial programs and overlaps between the content of high school courses and college courses having on student attrition?

- **What can colleges and universities do to meet the national need for school mathematics teachers?** What is the appropriate education for secondary school mathematics teachers and for elementary school teachers? How can the college and university faculty assist in implementing new standards for school mathematics? What program of continuing education will enhance school mathematics instruction?
- **What actions will spur renewal and revitalization of the mathematical sciences faculty?** What steps should be taken to ensure replacements for the aging collegiate faculty? What is appropriate preparation for collegiate teaching? What continuing program of scholarship for the nonresearch faculty is necessary to maintain the intellectual vitality of the profession? How can better compensation, incentives, and working conditions be achieved and maintained? What is necessary to maintain and enhance the research production of the faculty?
- **How can better monitoring of the mathematical sciences be implemented?** How can both professional organizations and government agencies cooperate in the collection and reporting of information? How can data be collected, organized, and disaggregated to provide a comprehensive view of the mathematical sciences community? How can mathematical scientists be identified in the nonacademic workplace?
- **How can colleges and universities prepare graduates who are more valuable and effective in the nonacademic workplace?** What changes would make mathematics graduates more valuable to business and industry? How can the full potential of the contributions of mathematical scientists be explored? What new educational programs could diversify the employment opportunities for mathematical scientists? Are there unrecognized opportunities for Ph.D.s in the mathematical sciences?

These issues center on the mathematical sciences enterprise in U.S. colleges and universities, but they have implications for all of society. In order to ensure a healthy flow of mathematical talent, a flow required to feed a technological society, this challenge of numbers must be met.

Figure Credits

Figure 1. *Handbook of Labor Statistics*. Bureau of Labor Statistics, U.S. Department of Labor, Bulletin 2217, Washington, D.C., June, 1983, pp. 164-171. *Workforce 2000, Work and Workers for the 21st Century*. Johnston, William B., and Packer, Arnold E., Hudson Institute, Indianapolis, Indiana, June, 1987.

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Figure 5. "Annual AMS Survey Reports 1976 to 1986," *Notices of the American Mathematical Society*, American Mathematical Society. "Annual AMS-MAA Survey Reports 1987 to 1988," *Notices of the American Mathematical Society*, American Mathematical Society. Various Authors.

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The Collected Papers of R. H. BING

Sukhjit Singh, Steve Armentrout, Robert J. Daverman, Editors

A powerful mathematician and a great problem solver, R. H. Bing laid the foundation for a number of areas of topology. Many of his papers have continued to serve as a source of major theoretical developments and concrete applications in recent years. One outstanding example was Michael H. Freedman's use of Bing's Shrinking Criterion to solve the four-dimensional Poincaré Conjecture.

This two-volume set brings together over one hundred of Bing's research, expository, and miscellaneous papers. These works range over a great variety of topics in topology, including the topology of manifolds, decomposition spaces, continua, metrization, general topology, and geometric topology. In addition, there are a number of papers in the areas of convex functions, linearity, and conformal varieties. The introductory section in the first volume provides

historical background on Bing's life and achievements.

This collection will appeal to mathematicians in all areas, and especially those in topology, as well as students, historians, and educators in the mathematical sciences, for it provides a complete historical summary of the mathematical events in the life of the man and the mathematician, R. H. Bing.

Contents:

I. R. H. Bing: An introduction; An editorial preface; R. H. Bing: A study of his life, by S. Singh; A chronology of R. H. Bing; Ph.D. students of R. H. Bing; R. H. Bing: October 20, 1914–April 28, 1986, by R. D. Anderson and C. E. Burgess; Abstracts by R. H. Bing; II. Papers of R. H. Bing; III. Classifications of works of R. H. Bing; Publications of R. H. Bing: Classified by the year; Publications of R. H. Bing: Classified by subject matter; Works not included in these volumes; Permissions.

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Interview with David A. Sanchez

David A. Sanchez, professor of mathematics and provost at Lehigh University, has been appointed Assistant Director for Mathematical and Physical Sciences (MPS) for the National Science Foundation. In his new position, he will oversee five research divisions, including the Division of Mathematical Sciences (DMS). The following interview was conducted by *Notices* Staff Writer Allyn Jackson on 5 April 1990.

Notices: Congratulations on your appointment. The new David Report will be making a "balance argument", saying that funding for mathematics is out of balance with that for other sciences. Would you care to comment on this?

Sanchez: We were advised at one time when we wrote that report that balance isn't going to win the day. When you look at the balance argument, you see that it's also "balanced" with an argument about the increased responsibility of the community for mathematics education. There was a real conscious effort on the part of the writers of the David II report, including myself, to moderate the argument so we didn't say, "We issued this report 10 years ago, and here's where we are, we haven't gotten it". Otherwise people would say, "Well, okay, wait another 10 years. What have you got to tell me that's new?" ...

Notices: Within the MPS directorate, is mathematics in balance with the other disciplines?

Sanchez: It's gotten larger increases, but then again it was a small potatoes operation before. It's a tough question, because of the differences among mathematics, astronomy, physics, chemistry, and materials research to decide what a balance is or what it should be... That's the problem with this crazy directorate. But I think basically mathematics has done very well, and—this is something the physics community shouldn't misinterpret—I think mathematics will continue to do well. But as well as it wants? No.

Notices: In the 1990 budget plan, mathematics got the largest increase. Some divisions even took a cut, when

you take inflation into account. Were some of the other divisions resentful?

Sanchez: No, I haven't detected that. That's an interesting question. One of the things I bring to this job is four years as a university administrator. If I think of my five divisions as colleges, I face the same kind of problems. One of the things you have to have is a budget allocation process that isn't painful, that people understand. And somebody has to make the decision (me) and then, with respect to the other assistant directors, [NSF Director Erich] Bloch has to make the decision. I suggested this about a week ago, to [the MPS divisions], and they said that was great, it's a wonderful idea. We all prepare requests, and we all lay them out, and everybody gets to talk about what they think is important, and I listen, and I say, why do you think that's better?... That had never been thought of, and I suggested it, and suggested it also as the model for how my directorate would work with the other directorates.

Now, I suggested this in a memo to Bloch, and it met with mixed reaction, because they are *not* used to dealing with that kind of a budget process. But when times get tough, you can defend your budgetary decisions if you're open about it. So if somebody comes up to the biology director and says, how come MPS got this percentage? You can say, well, we thought about it, we talked about it, and I'm satisfied, don't go criticize them. You might criticize the decider, but he's got to make an eventual decision. But don't go criticizing Sanchez, because he got more for mathematics than biology. It's got to be an open process and a fair fight.

Notices: That process would also help collaborative efforts, which Bloch himself wants to see more of.

Sanchez: That's right. If you get people to stop thinking "turf" and start thinking "collaboration," one of the ways you can do it is to make sure everybody knows what everyone's doing...

Notices: [During today's meeting of the NSF's Mathematical Sciences Advisory Committee, Science and Engineering Education (SEE) Director Bassam] Shakhshiri said that people have to avoid making "invidious comparisons" between funding for research and education. Yet

Congress has been giving large increases to SEE, above what NSF has requested.

Sanchez: [During a recent hearing with Bloch and Senator Carey of Nebraska], Carey was pounding on the table, saying "What are you going to do about the President's mission that says we want to be Number One in the year 2000? ...What are you going to do, Mr. Bloch, how are we going to get there?" I asked myself a question: Suppose we decide, we're going to marshall our resources to become Number One in 6th grade science education and 12th grade chemistry education in the year 2000. If we embark on this program, we might suddenly realize that about 1995, we're 20th in the world in mathematics research and 50th in the world in physics research. This is the dichotomy of mission—that the Foundation has to carefully balance and sort of resist the idea that we're going to become the science manpower-womanpower pool of the whole government, of the whole country. I worry about that... It's good that the Congress and industry, and all these folks are worried about math and science education, and these star-studded panels of governors and people are issuing these manifestos, and all that. I think that's great because it's getting people excited about it, and by God, it's time. But I worry that we have to also have this other mission and that has to be done. And if it isn't we're going to be in real bad shape 10 years down the line.

[Presidential Science Advisor D. Allan] Bromley, and the committee of science advisers to Bromley, are going to be looking at that question, that somehow, as you put these big things on line—Hubble space telescope, the Supercollider, and all that—somebody has to have the responsibility for putting in the human infrastructure needed to make the thing work. What if you had a Supercollider and nobody showed up? And it shouldn't be NSF, unless we get the funds for it. Somebody else should be out there saying, if DOE's going to do this, if we're going to build a Supercollider, we also ought to throw in \$5 million, or whatever it takes, to put in postdoctoral and graduate fellowships in particle physics.... There has to be a collaborative effort [among government agencies] to look at the whole human resources question. It can't just be NSF's bailiwick, just as I don't think K-12 science education should be NSF's bailiwick. We share responsibility with a lot of folks...

Notices: *You're going to be faced with some difficult choices balancing those kinds of things (like large research facilities, or the Superconducting Super Collider, that are very visible) with something like mathematics, which is the quintessential small science.*

Sanchez: And I have probably the most nightmarish directorate of all, because it runs from mathematics—which could be computing time, pads of paper, chalk, blackboard and a little travel cost—to astronomy, which is major facilities, big scopes, that kind of thing. Then

you've got chemistry in there, with laboratory science, and physics, which is different, and materials, which is really a mix of physics, chemistry, and engineering. It's a tough call.

Let me talk about the question in general. I think the pressure on the entire scientific community—the small science-big science question—is really beginning to surface now. Physics is upset about it, chemistry is upset about it, astronomy is upset about it. Bromley is concerned about it. How are you going to convince kids to go into mathematics when they don't see a career path out there? Well, how do you create a career path? Mary Wheeler hit it right on the nose: you have to have postdocs, graduate fellowships, opportunities for kids: "Hey, I'm going on to college, on to get a PhD on to graduate school; you can get supported!". So, I have a feeling that that pressure's going to come down from the top. It will be reflected in the budgets. How it will be reflected, I don't know. The David Committee's report is going to come out, it's going to say, we're still down there about 1700 [principal investigators], we recommended 2600, we're still 900 short. That's their little cry for, "What the hell are you doing for the individual investigator?" So, I can't say I'm going to find a magic panacea and start shifting funds.

See, mathematics doesn't have the schizophrenia that the other communities do. As you say, it's the quintessential small science. The physics community really has to ask itself, "How does the public feel about our hue and cry about small science when, down the road here, we're building this 7.9 billion dollar gadget—the NSF is building us this 200 million dollar thing"—Somebody's got to say...[if you want all that stuff, you can't have the other]. In mathematics, they can't say that. Mathematics in a sense has shown a greater interest in the whole manpower, funnel, pipeline question, so that it sits very well with respect to Congress. I think the budgets reflect that interest...

Notices: *Most mathematicians think the number one priority is to increase the number of principal investigators. Should that be the number one priority for DMS? A lot of mathematicians think it should be.*

Sanchez: No, it should be one of several. I think there are too many other things that have to be done. I don't like to set up a number one priority, because then you're automatically stuck in a mode of where well, if that's your number one priority, why don't you put all your money there? I really don't like to do that. It's an extremely important priority, there's no question about it. Is it as important as increasing the number of mathematics majors? That's a tough question. Let's see— if we produce three more math majors across the country at every institution of higher learning, we would produce about 500 new Ph.D.s in mathematics [because it takes about 10,000 B.A.s to produce 500 Ph.D.s]. That's a very

important priority. Now I have a bunch of PhDs, I have opportunities for them—jobs; postdocs; if they're good researchers, support funds. So that question is intimately tied with the question of, should we have 600 more principal investigators? See, it's a whole chain-of-events kind of thing.

Notices: Another priority the Advisory Committee has been discussing is ways to get more people into circulation in the research community. The idea of small research grants—for travel, visitors, equipment, etc.—coordinated by the AMS has been discussed. What do you think of that idea?

Sanchez: I don't have any problem with that. There is this viewpoint that, somehow, this is the loser's game—the loser's bracket of the NCAA Mathematics Finals! You got in the loser's bracket, so you go here and apply for these grants, and the winner's bracket goes on and gets the two month's summer support, travel to Europe and all that. I don't think of it that way. If you've got a fixed pie, there are only so many ways you can slice it. The question is, is it encouraging people to do mathematics?

I like this idea that I think is being bubbled around of seed money grants, where a program officer has a certain amount of discretionary money, and can just read a proposal—especially from a young investigator—and say, "Gee, that sounds really good", maybe bounce it off one reviewer... Fine, fund the proposal. Forget about the peer review and everything else, fund the proposal and say, "We think it's a nice idea, why don't you pursue it for a year or two, and then if it looks really good, you can go into the regular granting process". I don't have any problem with that. Does that mean that that person is not as good as the person who went through a formal granting process at NSF or who tags onto a block grant? Come on... I like some of these ideas.

I think the most explosive, dangerous idea—and that's something that has to be looked at across all scientific disciplines—is this concern about capping grants. Mathematics is just a threadbare science. I can speak as one mathematician—we're a happy bunch of poverty-stricken scholars. And that shouldn't be meant pejoratively, but we're not a big-demand operation. And if we took the lead on [salary caps], I think that would be a bad sign. I think that's a decision that has to be made way up there, to say, we're just going to cut across the board. That's a decision that all the divisions have to discuss...

But on the other hand, to say we've got some more innovative ways to use our money, to try to keep mathematicians alive, doing things, creating things—that's no problem, I don't think anybody would criticize that. Because everybody realizes there's only a certain amount of grant money out there. So if you've got people

who are trying to come back into mathematics—they've been out of research 5-6 years because they got involved in teaching or administration, and now they're trying to come back—these are fine researchers who maybe dropped out of doing research, and now they're coming back. What do you do about that? Well, I don't think they're second-class citizens. Eventually, the quality will rise to the top, and they'll be the people applying for the regular grants program. Money's tight. I would certainly, at certain times in my career, have appreciated the ability to garner a little grant to support some travel or bring a colleague to work with me. And I was supported by the NSF for a number of years, and not supported in other years...

One of the things that's hurting us right now is the inflationary cycle of faculty salaries versus fixed budget for research monies, versus academic year support, which mathematicians don't get, but other disciplines do... If you decided to take away academic year support in the medical schools, you could demolish whole budgets of big universities, because they rely a lot on research grants supporting faculty so that they can take that money.

Notices: NSF does not give much academic year support, does it?

Sanchez: It's not an agency where there's a lot of academic year support. DMS doesn't do it at all. There are other areas of the sciences and in engineering where there is some, but it is not a major portion of the NSF budget. On the other hand, it is a portion. And if you want to say, "We've got to try to squeeze more dollars into the research pool", how do we do it? If you start going after academic-year support, there are going to be a lot of college presidents who come roaring down to Bloch's office and start pounding on the table...

Notices: Any further comments?

Sanchez: I like to think that this job does require a modicum of competence and good will. I think one of the things that's really nice, that I like, that I've seen, is—austerity (or maybe poverty!) produces brotherhood. I think all the directorates are beginning to feel a lot of pain, a lot of concern about some of these issues. And consequently I see much more collegiality among the directorates. I get along well with [the other assistant directors]. There's a lot of talking among ourselves. I think that's healthy, and may not have been the case before. There's a lot more of a sense of "We've got a really serious problem", not, "Hey, that's your problem, not mine"... I think that's good. And I like working in that kind of atmosphere, because I like to take shots, I like to have informal talks, criticize, and not feel like I'm stepping on people's toes. If you're willing to be honest with each other it makes for a better working environment, and I've seen that. And I hope it continues.

The Second Report of the 1989 Annual AMS-MAA Survey, reporting data on faculty age and retirement, departmental composition, fall enrollments, majors, graduate students, and an update on employment of the 1988-1989 doctorates, will appear in the July/August issue of *Notices*.

Doctoral Degrees Conferred 1988-1989

Supplementary List

The following list supplements the list of thesis titles published in the November 1989 issue of *Notices*. Each entry contains the name of the recipient and the thesis title. The number in parentheses following the name of the university is the number of degrees granted by the department.

MINNESOTA

University of Minnesota, Minneapolis (4)

STATISTICS

Ibrahim, Joseph, *Incomplete data in generalized linear models*.

MacEachern, Steven, *Sequential Bayesian bioassay design*.

Samaranayake, Kumarasiri, *Bernoulli K-armed bandits with dependent arms*.

Weiss, Robert, *The comprehension and computation of Bayesian diagnostics*.

OHIO

University of Cincinnati (1)

MATHEMATICAL SCIENCES

Konsowa, Mokhtar, *Random walks on trees*.

OKLAHOMA

Oklahoma State University (2)

MATHEMATICS

Winters, Bobby Neal, *Proper planes in Whitehead manifolds of finite genus at infinity*.

Young, Paul Thomas, *Radii of p -adic*

convergence of generic solutions of homogeneous linear differential equations.

PENNSYLVANIA

Pennsylvania State University (2)

STATISTICS

Markatou, Marianthi, *Robust bounded influence tests in linear models*.

Roeder, Kathryn, *Methods of spacings for semiparametric inference*.

TEXAS

University of North Texas (4)

MATHEMATICS

Abbott, Catherine Ann, *Operators on continuous function spaces and weak precompactness*.

Gurney, David, *Bounded, finitely additive, but not absolutely continuous set functions*.

McCabe, Terrence William, *Minimization of a nonlinear elasticity functional using steepest descent*.

Sutinuntopas, Somporn, *Applications of graph theory and topology to combinatorial designs*.

CANADA

Université de Montréal (4)

MATHÉMATIQUES ET STATISTIQUE

Guenoun, Zine El Abdine, *Existence de solutions au sens de Caratheodory pour des problèmes aux limites non linéaires*.

Meloche, Jean, *Sur l'estimation de densités symétriques*.

Meneghini, Quirino, *Estimation de composantes de la variance et les estimateurs contractants*.

Nguyen Ba, Truong, *Comparaison des suites et des arbres: Nouveaux algorithmes*.

University of Calgary (5)

MATHEMATICS AND STATISTICS

Brochet, Jean-Michel, *Extremal problems in infinite graphs and infinite orders*.

Farid, Farid O., *Spectral properties of diagonally dominant infinite matrices*.

Fung, Tak-Shing, *Topics in Brownian motion with application in biophysics*.

Wong, Hsiu-Yuan Su (Josephine), *Maximum asymptotic variances of Maximum likelihood estimators of location with auxiliary estimates of scale under symmetric contamination*.

Yang, Qiduan, *Topics of homomorphisms in representation theory of symmetric groups*.

Errata

The thesis title for Karen R. Pinney (Mathematics, University of Chicago) was incorrect in the November 1989 *Notices*. The correct title is "Convex results for domains in smooth projective varieties."

Martha Hastings (Mathematics and Computer Science, St. Louis University) was incorrectly listed in the supplementary list of doctoral degrees conferred 1988 in the November 1989 *Notices*. The correct date is 1988-1989.

Forum

The Forum section publishes short articles on issues which are of interest to the mathematical community. Articles should be between 1000 and 2500 words long. Readers are invited to submit articles for possible inclusion in Forum to:

Notices Forum Editor
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

Some Thoughts on "Everybody Counts"

Edward G. Effros

University of California, Los Angeles

In a recent letter to *Notices*, Eleanor Palais eloquently expressed her doubts regarding the latest "Everybody Counts" movement for reforming mathematical education. Specifically she asked:

Why hasn't the focus of 'Why are the students' scores so poor?' been more on the students themselves, rather than on the schools, the teachers, and the curriculum?

Ms. Palais' letter touches upon concerns that many of my colleagues and I have regarding the National Research Council (NRC) publications "Everybody Counts" and "Reshaping School Mathematics", and the National Council of Teachers of Mathematics (NCTM) "Curriculum and Evaluation Standards for School Mathematics". These reports have failed to relate the sorry state of mathematical education to the general context of educational failure in the United States. Instead, the authors have attempted to remedy the problem with a *livelier* mathematical curriculum and with a much greater emphasis on calculators and computers. In this article I will address certain aspects of the proposed curricular changes, and I will then go on to consider possible approaches to the real problems that were avoided in these reports.

For many of us, the weakest component of the "Everybody Counts" program is the great stress placed

on calculators and computers. Contrary to the claim in the "Standards" that

There is no evidence to suggest that the availability of calculators makes students dependent on them for simple calculations,

many of our students have already become *calculator idiots*. At UCLA we are now witnessing the appearance of students who are so hooked on their calculators that they cannot multiply 9 by 7 in their heads. It is difficult to see how such students will be able to do the *estimations* emphasized in the new program if they cannot instantly do such simple calculations. If indeed the problem with our current elementary school curriculum is that the

current goal in most elementary school classrooms is far in excess of what is needed for tomorrow's society,

then why is it that many of our students are unable to do even the simplest *paper and pencil* calculations? Banks advertising positions in the *UCLA Daily Bruin* now feel it necessary to indicate that candidates "should know fractions".

The "Everybody Counts" de-emphasis of manual calculation in high school mathematics is even more problematical. In these reports it is suggested that owing to the development of calculators that can do algebraic calculations, algebraic facility is no longer as important as it once was. But this misses the point that we are not concerned with whether or not our students can find subtle factorizations of fifth degree polynomials. Many of our calculus students cannot factor quadratics! When you teach calculus, the students must have the simple algebraic manipulations in their heads and not in their calculators.

Few would question that calculators and computers can be used to great effect at all levels of education. But they will have little or no effect on the basic *innumeracy* that we are currently witnessing. Our students are simply not fluent in the mathematical language. As in any other language, drill and practice remain the most important

tools at our disposal for learning the first principles of mathematics.

Of course advocates of "Everybody Counts" will reply that safeguards against overdependence on calculators and computers are included in these proposals. Nonetheless, the statement in "Reshaping School Mathematics" that

[one of] the two fundamentally important issues discussed in 'Everybody Counts' and in the NCTM Standards ... [is the] ... changing role of calculators and computers in the practice of mathematics

will almost surely mislead many educators and politicians into regarding calculators and computers as a panacea. To illustrate what is already happening, consider the following story. Boston University recently took over the Chelsea school system in an attempt to reverse the educational decline of that district. In a letter to the editor of *Science*, Chairman of the Management Team of that project, Peter R. Greer, recently reported that

the University is in the process of installing \$600,000 worth of computer hardware and software in Chelsea's classrooms at minimal future cost to the Chelsea taxpayers.

This would be laughable if it were not so tragic. The director of the UCLA mathematics department computer lab, used by a relatively benign population, tells me that maintaining equipment generally costs 10% of the initial investment, and that one would have to have a full time person to advise the faculty on software, etc. In impacted school systems the administrators are not even able to keep the plumbing going. What are the chances that installations like this will still be running after a year? A teacher with only a quarter of Jaime Escalante's ability and dedication would have been worth far more than all the gimmicks.

It is well known that American students are failing in all of their academic pursuits, and in particular, *innu-meracy* is highly correlated with illiteracy. But the most disturbing development is that many of our students seem unable to concentrate, regardless of the subject. This was considered in an editorial written by Leonard Gillman, then President of the MAA, in 1987. After discussing the primary pursuit of students today (watching TV), he wrote

Mathematics requires intense concentration; television encourages nonconcentration. I sometimes wonder how many of my students are capable of concentrating on one idea, uninterrupted, for ten full minutes.

The same alarm is also sounded in Eleanor Palais' letter:

Students are not motivated and want only easy ways to get good grades without lifting a pencil. One has simply to walk into a public school math class and observe students with bored looks, slouched in chairs with arms folded. Often homework has not been done and the class must be invited to take notes, or even to open their books or to get a pencil ... I believe our young people today are doing poorly in their school work because they have been brought up as passive listeners in a TV generation. When I am teaching, my students are often glassy-eyed and watching what is happening as if I were a TV performer. The students do not receive what is being said!

The simple facts are that many of our students are not studying, and that we have allowed the entire educational apparatus to decay. No form of mathematical curriculum fiddling or new techniques of *presentation* will have an appreciable effect on these fundamental problems. The societal causes for this situation are well-known, and some of them were briefly summarized in "Educating Americans for the 21st Century":

... a fundamental improvement in K-12 mathematics can be hoped for only within the framework of a general improvement of the total school environment. ... difficulties facing the teaching community ... [include] ... low teacher salaries, low prestige, lack of support by society, lack of discipline in the classroom, irregular attendance, etc.

The basic flaw in the NRC and NCTM reports is that they have failed to address these basic issues. Perhaps the disclaimer stated in "Educating Americans for the 21st Century" that these problems

are societal in nature and fall outside both the mandate and the competence of this group

was appropriate for the NCTM, but was that really the case for the National Research Council committees? With such impossible constraints, the NRC committee members might have tried for some sort of holding action. Instead they have sought ways of making mathematics more attractive to students, and to look for "technological fixes". This defeatist attitude is reflected in a letter by Ron Douglas published recently in the *AMS Notices*. Replying to Eleanor Palais, he wrote

... although we are somewhat reluctant to admit it, kids are different. While the wistful comment that the real problem is getting students to work may have some validity, it is analogous to stating that the problem with night is that the sun doesn't shine.

Ironically, this pessimism regarding our students co-exists with an unbounded optimism in the efficacy of

curricular change. I cannot resist recalling one of the thrusts in "Educating Americans for the 21st Century":

A plan of action for improving mathematics, science and technology for all American elementary and secondary students so that their achievement is the best in the world by 1995.

There is certainly much of value in the "Everybody Counts" movement. If one is able to deemphasize the calculator-computer aspects of the reports, there are many positive suggestions for reinvigorating the curriculum. Some of the unimaginative approaches that are currently being used in the reaction to the new math should be eliminated. Nonetheless, these steps are not likely to have much effect in the current educational environment. The disappointment that will inevitably ensue will even further erode the credibility of mathematical educators. That is why it was so unfortunate that the members of the NRC committees did not address the need for much more drastic reforms.

Educational failure is not the only problem that our Democratic society faces, and in some of our other difficulties we have developed more promising strategies. As in the case of drugs, crime, disease, and environmental destruction, we must have grass roots movements for social change if we are to have even a chance of success. Specifically we need organizations and lobbies that will insist on a change in the attitudes of parents and children alike. Even simple ad campaigns would have an effect. We should have messages on TV stating that "If you don't read a book, how can you expect your child to read a book?", or "Keeping this TV set on can damage

the educational potential of your children". We must also revise our educational philosophy by making it clear to everybody that the best way to "feel good about oneself" is to be good. We must make it our goal to stir our somnolent fellow citizens into stemming the further decay of our culture.

In conclusion, although "Everybody Counts" and the "Standards" have many useful recommendations, they are flawed by an overemphasis on calculators and computers, and they provide little hope for reversing the continuing decline.

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3. "Curriculum and Evaluation Standards for School Mathematics," National Council of Teachers of Mathematics, 1989.
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5. L. Gillman, "Two Proposals for Calculus," *FOCUS*, September 1987.
6. E. Palais, "A Differing View on Mathematics Education Reform," *Notices of the AMS* (36) 1989, 1189-1191.
7. R. Douglas, "A Differing View on Mathematics Education Reform," *Notices of the AMS* (37) 1990, 263-264.
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Some Mathematical Questions in Biology: MODELS IN POPULATION BIOLOGY

Alan Hastings, Editor

(Lectures on Mathematics in the Life Sciences, Volume 20)

Population biology has had a long history of mathematical modeling. The 1920s and 1930s saw major strides with the work of Lotka and Volterra in ecology and Fisher, Haldane, and Wright in genetics. In recent years, much more sophisticated mathematical techniques have been brought to bear on questions in population biology. Simultaneously, advances in experimental and field work have produced a wealth of new data. While this growth has tended to fragment the field, one unifying theme is that similar mathematical questions arise in a range of biological contexts.

This volume contains the proceedings of a symposium on Some Mathematical Questions in Biology, held in Chicago in 1987. The papers all deal with different aspects of population biology, but there are overlaps in the mathematical techniques used; for example, dynamics of nonlinear differential and

difference equations form a common theme. The topics covered are cultural evolution, multilocus population genetics, spatially structured population genetics, chaos and the dynamics of epidemics, and the dynamics of ecological communities.

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Computers and Mathematics

Edited by Jon Barwise

Editorial notes

Much of this month's column is taken up with issues raised in previous columns. The two main articles have to do with the current and future feasibility of electronic mathematical journals, and with pedagogical issues raised by computers. In addition, there are a couple of letters generated in response to previous columns. Finally, there is a review of "Linear Programming by Fractions."

The "Computers and Mathematics" column will take a vacation in the next issue of *Notices*. This will allow the editor a rest and will also allow us to get the average number of pages per issue more in line with what we are allowed. The column will return in September.

Computers in research

This column is still very eager to get articles reporting on the use of computers in mathematical research, as well as articles on the mathematics of computation. Authors will discover a higher readership than for most articles written for a mathematical audience. Submissions should be of about 3–5 pages in length, and informal in nature. Send them to:

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Ventura Hall

Stanford, CA 94305

email: barwise@csli.stanford.edu

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in relation to my much earlier article, "Program Verification: The Very Idea" [4]. Dudley especially claims (a) that C.A.R. Hoare has been misquoted by us both, (b) that I have "quoted selectively" from Hoare, and (c) that I have thereby misrepresented his position. (a) Dudley is correct in observing that the words "in any given environment" were omitted from the quotation from Hoare that appears on p. 1052 of [4]. They were originally displaced by "...", which inadvertently disappeared between the penultimate and the accepted version of my paper. This is something I overlooked at the proof stage and for which I assume responsibility.

This omission would be important, of course, if it made any difference at all to my position. But since a "given environment" could be an *abstract* one concerning an abstract machine or a *physical* one concerning a physical machine, every argument that I have advanced remains sound, whether or not the missing four words are restored. Dudley is right, but it does not matter. (b) Dudley is also correct when he alleges that I have "quoted selectively". It is of the nature of "quotation" that quotations are "selective". I deliberately selected those passages from Hoare that were relevant to the issues which I wanted to address. In fact, I selectively quote Hoare on p. 1048, on p. 1052, on p. 1058, and on p. 1059 of [4]. But surely there is nothing improper here. (c) More to the point, in relation to other passages from Hoare that I discuss on p. 1059 of [4] and that Barwise mentions on p. 848 of [1], Dudley asserts, "neither Fetzer (in [4] or [7]) nor Barwise (in [1]) tells us that Hoare [8] went on as follows:

HOWEVER ... [emphasis in original]
These are general philosophical and moral principles, but all the actual evidence is against them. Nothing is as I have described it, neither computers nor programs nor programming languages nor even programmers."

Once again, he is literally correct but substantially mistaken. It is true that I did not discuss the passage that Dudley has selectively quoted in [4] or in [7], but I did discuss it—at some length—in [5], pp. 380–381! I would like to think that scholars from prestigious institutions such as MIT always do their homework before accusing others of having "done us a disservice". This letter-like others I have encountered—indicates that is not the case. (I discuss another quote he mentions on p. 124 of [2] in [6], pp. 511–512.)

Correspondence

The final word on program verification

The following letter comes from James Fetzer, University of Minnesota, Duluth, in response to the letter from R. Dudley on program verification. I think that with this response, we have devoted enough space to this issue in this column.

The letter from Richard Dudley [3] raises a number of issues in relation to a recent column by Jon Barwise [1] and

Dudley also remarks that "essentially everyone agrees that it cannot be proved, in the strict mathematical sense, that a physical computer will execute a program correctly" [3], p. 123. (Notice the fudge factor in using the word "essentially"! This claim is meant to imply that the whole dispute is much ado about nothing. The strength of the debate and the extent of the controversy suggest that, here as elsewhere, Dudley has not made his case.

References

- [1] J. Barwise, "Mathematical Proofs of Computer System Correctness," *Notices of the AMS* 36 (September 1989), pp. 844-851.
- [2] J. Dobson and B. Randell, "Program Verification: Public Image and Private Reality," *Communications of the ACM* 32 (1989), pp. 420-422.
- [3] R. Dudley, "Program Verification," *Notices of the AMS* 37 (February 1990), pp. 123-124.
- [4] J.H. Fetzer, "Program Verification: The Very Idea," *Communications of the ACM* 31 (1988), pp. 1048-1063.
- [5] J.H. Fetzer, "Program Verification Reprise: The Author's Response," *Communications of the ACM* 32 (1989), pp. 377-381.
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- [7] J.H. Fetzer, "Mathematical Proofs of Computer System Correctness: A Response," *Notices of the AMS* 36 (December 1989), pp. 1352-1353.
- [8] C.A.R. Hoare, "Mathematics of Programming," *BYTE* (August 1989), pp. 115-121.

Responses to Miles' article

The following letter was received in response to Phil Miles' review of *Derive*, and my comments on this review. It is from Paul Zorn and Arnie Ostebee of the Department of Mathematics, St. Olaf College, Northfield, Minnesota 55057. A response from Miles follows. A later reaction by Ed Dubinsky and associates in the Mathematics Department at Purdue University appears as a separate article.

In his review of *Derive*, Phil Miles mentions his concerns for the difficult work of teaching *students* to do mathematics when "a perfect version of The Answers lies only a few keystrokes away . . ." In an editorial comment, Jon Barwise seconds Professor Miles' concern, worrying that "symbolic mathematics packages may make it even harder for our students to understand the meaning of mathematics."

In our view, Miles and Barwise have things backwards. Symbolic mathematics packages put a host of Answers—literally—at students' fingertips. This may be a problem, but it is certainly an opportunity: the opportunity to focus on The Questions as well as on The Answers. Many of the problems undergraduates have as they try to "understand the meaning of mathematics" stem directly from an overemphasis on finding The Answers. Questions whose Answers really lie a few keystrokes away are seldom very interesting. Should we be surprised that students care so little about them?

Symbolic mathematics packages may render some skills and genres of Questions obsolete; which ones, it is really too early to tell. Just the same could have been said, long ago, of Arabic numerals and movable type. Technology can always be used inappropriately, to bad effect. But, at least as likely, symbolic computing might help students see beyond the morass of symbolic manipulation, in which so many of them remain mired, to the better, more interesting, and more "mathematical" delights beyond.

Miles response:

Ostebee and Zorn have restated the National Research Council (NRC) position with the added inducements of movable type, Arabic numerals and delight. If, as is not the case, it were necessary to give up all of these for meaning, I would cheerfully do so, since meaning is the basis of human communication.

If one sees algebra as a morass of symbols, whose only purpose is to be processed mechanically, one is cut off from the most common meanings of mathematics, whether or not one has a symbol manipulator. Helping average high school students find the meanings in algebra will require substantial changes – reforms – in current teaching practice. Making these changes will require effort, ingenuity and dedication – all the help that can be had, including calculators and computers. Is anyone out there working along these lines?

International availability of *Exploring Small Groups*

Several letters from abroad have asked how their authors could obtain the program *Exploring Small Groups*, recently reviewed here by Suzanne Molnar. Professor Molnar writes that it can be obtained from:

Harcourt, Brace, Jovanovich, International
6277 Sea Harbor Drive
Orlando, Florida 32887
Phone: 407-345-3800
Telex: 441489 HBJ UI
Fax: 407-352-3395
Cable: HBJOFA Orlando

Pedagogical Issues in the Use of Computers

Ed Dubinsky*

I enthusiastically support the continued discussion of pedagogical issues in Jon Barwise's *Computers and Mathematics* column. In his review of *Derive* (*Notices*, March

*Ed Dubinsky is Professor of Education and Mathematics at Purdue University. He is editor of *UME Trends* and does research in how people learn undergraduate mathematics. His email address is bbf@j.cc.purdue.edu. He was assisted by Nancy Baxter, Al Cuoco, Jennie Dautermann, Gary Levin, Uri Leron and Don Muench.

1990), Phil Miles is concerned that teaching in the presence of computer algebra systems "will be hard indeed", and Barwise calls editorially for "other kinds of software."

I would like to respond to the issue Miles has raised and point out some alternative approaches to software development for mathematics education. At the end, I will give some details about a particular development with which I have been professionally involved.

Computer Algebra Systems

Miles says, in part,

"Teaching is hard. One must engage oneself with one's students and work to engage them with the materials. ... Doing all this when a perfect version of The Answers lies only a few keystrokes away will be hard indeed."

Miles doesn't tell us much about actual use of *Derive* in teaching situations. I think what one often finds is that with symbolic manipulators, not only are the answers a lot less than perfect, but dealing with the imperfections can be an effective way for your students to learn from computers. For example, pick a fourth degree polynomial and use a computer (or hand calculator) to graph it. How many zeros do you see? Usually not four. Is that because two or more are complex, or multiple, or is it because some zeros are hidden by the scaling? Demana and Waits [3] build an entire pedagogical approach they call the *complete graph of an expression* around this "imperfection".

For effective use of computer algebra systems, I could mention other examples such as Kathy Heid's work [5] which suggests that with *MuMath* (the predecessor of *Derive*), teaching manipulative skills can be done in a very short time, and the way can be opened to work with the students' conceptual understanding. I could describe how Dave Smith uses MathCad to help students learn about fitting curves to data and making predictions [9]. Alternatively we might consider Paul Zorn's suggestion that using a symbolic computer system to solve certain problems can facilitate the student's understanding, at least of what the problem is [2].

We need to read more about such things. In addition to important things about computers in mathematics education that appear in this column, we need to read descriptions of what is being tried in the classroom — the successes and the failures. We need to read about research on how people can (or can not) learn with computers and encourage more (perhaps by establishing an appropriate journal?). And we need to be aware of publications that are forthcoming. For example, I advise people to watch for a book on the calculus projects by MAA's CRAFTY, a book on computer labs edited by Carl

Leinbach, and a volume on Computer Algebra Systems by MAA's Subcommittee on Symbolic Computation.

Other Kinds of Mathematics Education Software

Barwise says, in commenting on Miles' article,

"... mathematics courseware has to be developed with this pedagogical problem squarely in mind".

It should be, it is, and with luck it will continue to be. For example, Schoenfeld is developing a computer environment that uses a variation of *GreenGlobs* to help students learn about slopes [7]. Kaput and a number of groups are developing and using software designed to help students to mentally coordinate three kinds of representations of a function — expression, graph, and table of values. There are several projects which are developing software for use in learning analysis and differential equations. Finally, I would like to say a few words about the work of a group of people (including myself) who are developing mathematical courseware in which students write programs and, as a result, construct in their minds important mathematical objects and processes. We use the programming language *ISETL* which is reviewed by Don Muench in the same issue in which appear Miles' article and Barwise's comment. I would like to suggest in the rest of this article that the work being done using this language is a contribution to the development Barwise is calling for.

Learning Mathematical Concepts through Programming

The work with *ISETL* is based on research into the constructivist approach to explaining how mathematics is learned. An introduction to this approach can be found in an article by Annie and John Selden [8]. One of its main points is that the development of mathematical understanding comes from mental constructions of mathematical objects and processes. One line of research and development is to delineate specific constructions and to design computer activities, the doing of which will induce students to make those constructions. If this is done in a computer lab, in the context of students trying to understand mathematical situations and solving problems, and if it is connected with appropriate classroom discussions, then experience is showing that it can lead to a significant improvement in students' understanding of mathematics. We are seeing this improvement in all kinds of students, including those who have great difficulty understanding mathematics.

Because the syntax of *ISETL* is so close to standard mathematical language (see [6] for examples), students do not have much difficulty with programming issues. All of their struggle is with understanding the meaning of

mathematical statements which *ISETL* can interpret and act on. It is through this struggle that their understanding grows.

We have implemented this approach using *ISETL* in calculus. Students write procedures to represent functions and their compositions. This turns out to help with the chain rule. They also perform a number of computer tasks that lead to the fundamental theorem of calculus (see [4] for details).

We have also worked with *ISETL* and this pedagogical approach in discrete mathematics [1]. For example, one procedure which the students write will implement a Boolean valued function of the positive integers which comes from a statement to be proved by induction. They will then write a procedure for the corresponding implication valued function. After this, they have little confusion between proving $P(n)$ and proving $P(n) \Rightarrow P(n+1)$.

Finally, we are developing an application to a course in abstract algebra. Students construct computer programs that look like standard mathematical definitions and test sets with binary operations for being groups, subsets for being subgroups and subgroups for being normal. They actually construct the set of cosets of a subgroup and can try to define a multiplication on it. They discover that it sometimes works and sometimes fails. After all of this, Lagrange's Theorem, quotient groups and the Fundamental Theorem of Homomorphisms become very accessible to a wide variety of students, including preservice high school teachers.

Conclusions

To summarize, I think it is fair to say that a great adventure is in progress and I think mathematics publications should be reporting more on what is happening in the classroom. A variety of computer systems are being developed, students are using tools to solve problems, working in computer environments to develop ideas and writing programs to construct mathematical concepts, first on the computer, and then in their minds.

It is, of course, not always easy. There has been some initial success, but many pedagogical problems remain. We hope that as mathematicians and educators continue to join in and pursue this line of pedagogical research and development, the use of computers will lead to substantial improvement in mathematical understanding on the part of all of our students.

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Ejournals

Leslie Burkholder*

Let's suppose it's 1995 and not 1990. You are starting up a new journal, perhaps with a title something like *Mathematics & Computers*. (It concentrates on topics much like those in this column.) After talking with colleagues and doing a bit of research, you've decided to make it an electronic journal. Publication and distribution of the journal is easy and quick. You just post issues to some of the international computer networks and your subscribers pick it off these networks later the same day. Some subscribers print out parts of the issues they receive but most read it on-line. In fact, you've decided to run the whole thing using the networks. Submissions are made to you electronically and sent out to reviewers that way as well. Turn-around time for these reviews is fast, really no longer than the time you give the reviewers to look over the submitted materials. And since there is no real limit on the size of an issue of the journal, accepted materials are published without delay.

There are more benefits yet. Materials published in the journal are not restricted to those that can be

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reproduced on a printed page. Sometimes people include animated graphs or a working program. Subscription costs for the journal are lower and so circulation is better. Storage problems for libraries are reduced: disks and tapes take up far less room than bound or loose paper volumes. Shelving and reshelving costs in libraries are reduced, too. Journal indexes are updated automatically by machines which read issues of your journal, so people making literature searches on topics covered by your journal are more likely to find out about it and its useful contents.¹

In 1995, producing *Mathematics & Computers* as an electronic journal rather than a paper one is a winner. But, of course, it's not 1995; it's 1990. Is producing your new journal electronically rather than publishing it on paper still a good idea?²

Some of your colleagues will unreservedly say "yes". They'll point out all the benefits and wonders depicted above and say "Why be a part of all the difficulties and costs associated with the current system of journal production? Certainly producing the journal electronically is better!". But consider how they reason. There are unquestionable benefits for all from people driving on the highway at 55 mph rather than 65 mph. There just are fewer deaths and accidents. But what should you do if most others on a filled highway are driving at 65 rather than 55? Your colleagues, if they are consistent, should respond "Certainly driving at the good 55 mph is better!". Unfortunately, the best thing, the safest for both you and others, is to drive at 65 rather than 55 when others are doing so. You are likely to cause fewer accidents that way; driving at 55, you are an obstacle to the safe flow of traffic. Which of the two speeds is best depends, in part, on what else is going on.

How does this point apply to the production of your new journal?

¹This description is based on Sharon S. Rogers and Charlene S. Hunt, "How scholarly communication should work in the 21st century", *The Chronicle of Higher Education* (18 Oct. 1989), A56, and Lauren H. Seiler, "The future of the scholarly journal", *Academic Computing* (Sep. 1989), 14-16, 66-69.

²Some journals are published and distributed partly or completely electronically, even in 1990. So some editors have concluded in favor of this method. In some instances the journals are distributed on various networks (BITNET, or the InterNet, for example), in some instances by disk, in others by a combination of electronic and paper means. Examples include the *Newsletter on Serials Pricing Issues* (tuttle@unc.bitnet), *Philosophy and Theology* (6035tal-lona@mucsd.bitnet), *Ejournal* (about the role of electronic media, emj69@albnvms.bitnet or ag6742@albnvms.bitnet), and *PSYCOLOGY* (a psychology newsletter, harnad@princeton.edu). *Tetrahedron Computer Methodology* (Pergamon Press) is a print and paper journal but each issue comes with supplements on disk. The editors of *Electronic Publishing* considered electronic distribution for that journal but decided against it. For their reasons see B. F. Brailsford and R. J. Beach, "Electronic Publishing - a journal and its production", *The Computer Journal* vol. 32 (1989), 482-493.

In 1995 you post issues of your journal to the networks and subscribers, both individuals and libraries, take it from there. Can you do this in 1990? Well, how many of your subscribers or potential subscribers have access to the networks? Perhaps in 1995 all of them will. But in 1990 many of them may not. Perhaps many of your potential individual subscribers are teachers of mathematics at small and not very rich colleges. Many of these do not have network connections.³ And what will the libraries want? Few libraries are set up to handle journals reaching them through computer networks. Well, perhaps the journal can be distributed on disk. This has many of the advantages of publication and distribution using electronic networks and most of your subscribers will have access to some machine. (Would they subscribe to *Mathematics & Computers* if they didn't?) In addition, it helps with one problem apparently solved by 1995: how to ensure a subscription income.⁴ It is hard (in 1990) to collect from people who just pull issues of the journal off an international network. Disks can be sent only to those people who have subscribed. But do you only produce disks that can be read by MS-DOS and Macintosh machines? What about those people with Apple IIs, on the one hand, and Sun workstations on the other? What about those who are still using terminals attached to mainframes? And are those library subscribers able even to manage disks? Some will want printed copies of your journal. So, for various reasons, will some of your computer-owning individual subscribers? So you will have to do print runs of your journal even if you can distribute some copies on disk.

By 1995, it seems, standards have been adopted that allow easy exchange over computer networks of not merely ordinary text but text containing strange ("non-ASCII") symbols and graphics. That's one reason why it's possible for you to send your journal out over the network and have your subscribers be able to read it on their different machines using different software at the other end. Can you manage this in 1990? In

³In 1989 membership in BITNET cost from \$750 to \$8000 annually in the US, depending on the budget of the institution. This excludes the cost of any additional needed phone lines, interface software, technical support, and personnel. See Daniel A. Updegrave, John A. Muffo, and John A. Dunn, Jr., "Electronic mail and networks: New tools for institutional research and university planning" (ms. available from ccnews@educom.bitnet).

⁴And perhaps with another which worries publishers, enforcement of copyrights. Disks may be copyprotected.

⁵Why would they want print versions? Perhaps they are just old fuddy-duddies or they may have found that, in order to read articles in the journal with comprehension, they print out everything anyway and read and annotate the printed copy. A number of studies show that people perform various text-comprehension tasks better from paper than from a computer screen, even when the screen is of the large display sort found on a workstation. See Wilfred J. Hansen and Christine Haas, "Reading and writing with computers", *Communications of the ACM* vol. 31 (Sep. 1988), 1080-1089 and references therein.

1990, while graphics can be exchanged over a network and displayed at each end by some machines, this is still a long way from a common ability. It is not even guaranteed that a word-processing document containing non-ASCII characters produced with one Macintosh will reproduce correctly when read by another. At the very least, similarly identified fonts have to be available on both machines, tabbing has to be set up properly, and so on. Of course this is not much of a problem for many journals. Some journals can get by pretty well with very plain text. But what if *Mathematics & Computers* contains graphics and all the sorts of odd symbols mathematicians are fond of using? You could provide the journal in different formats for people with different software and different machines to read it on. But this is going to be a lot of work, much of it not taken care of by a machine, copying and formatting and reformatting documents, with little guarantee that it will often enough yield an acceptable result. (And all of this, of course, will not exactly thrill your potential advertisers.)

By 1995, apparently, there is no longer any doubt that publishing in an electronic journal can be as effective as publishing in a paper journal. Potential contributors, worried about tenure and promotion decisions or, more altruistically, worried about getting the truth out to as many people as possible, have no doubts about the medium. Those who are sensibly concerned about their own futures take to heart a survey made as long ago as 1980 which showed that deans and senior faculty would regard publication in a refereed electronic journal of national stature as the equivalent for tenure and promotion decisions to publication in a printed journal.⁶ So in 1995, if your journal wants for good contributions, it will not be because it is electronically produced. Unfortunately, in 1990, nobody seems to believe this survey result. Even some of those who are enthusiastic about electronic journals think that electronic publication will not count for as much as print publication when it comes to tenure and promotion. The belief may be wrong, the result of confusion; publication in an electronic journal may not count for as much if such a journal is new and without an established reputation or whether it is wrong or not, there is reason for you to worry about getting good contributions. And others, the more altruistic ones concerned about spreading the word, think the readership of an electronic journal in 1990 will be too small. This too may be a mistake, readership may be as great or greater for some electronic journals as similar print and paper ones. But given a choice, these people will publish on paper rather than online. Those who favor electronic publication and distribu-

tion will point out the cost savings to be made, even in 1990, by this over traditional print and paper means of publication and distribution. But where do the savings come from? The cost of preparing camera copy and the cost of printing and distributing the issues obviously represents much of the expense of producing a journal. Richard Palais had experience analyzing the costs of journal production as a former trustee of the AMS. He estimates that the cost of preparing copy ready to be printed from would be next to nothing were authors to submit papers electronically, marked up in a way that could be turned by machine into stylistically acceptable camera ready form. This avoids the expenses of retyping in text, perhaps producing new versions of graphics, and laying out articles in the journal style.⁷ Even in 1990, although you cannot perhaps insist that authors submit papers in such a way, you can benefit from each such submission.⁸ And certainly it is cheaper to send out copy over the networks than it is to print, bind, and mail the same materials. Perhaps it is also cheaper to reproduce and distribute disks than printed paper, if distribution using the networks won't work. But some of the savings from electronic publication are only apparent. In 1995, it seems, as in 1990 for many existing electronic journals, publishers and editors are one and the same, faculty willing to devote their time and other resources to do not only the editing, but also many other aspects of the production and distribution of a journal. One reason why these journals look cheaper than counterparts produced and distributed by a regular publisher is that this time and these other resources (capital expenditures for equipment, for example) are not included in the calculations. So proponents of electronic publishing are sometimes comparing apples and oranges. Sometimes, they are comparing the costs of faculty produced electronic journals with print journals produced by regular publishers, rather than just the costs of electronic with print modes of production. Once the right comparisons are made, the question is: Do the undoubted real savings from electronic publication and distribution outweigh the difficulties listed in the paragraphs above of the medium in its current state? And then there is the further question of where the savings go. Enthusiasts for electronic publication and distribution assume that they will substantially end up in the subscriber's pocketbook.

⁷Personal communication.

⁸Many journals are now being prepared electronically with some cost savings. Manuscripts are submitted either by electronic mail or on disk and journal issues are sent to printers either as marked-up documents (for example, using TeX or Scribe) or camera-ready copy produced on local laser printers. The editor of *Dialogue*, a Canadian journal of philosophy, recently said he thought that this mode of production "could reduce the cost of the journal by as much as 40% a year". Steven Davis, "News from *Dialogue*," *The Bulletin of the CPA* (Nov. 1989), 17-18.

⁶Lauren H. Seiler and Joseph Raben, "The electronic journal", *Society* (Sep./Oct. 1981), 76-83.

In the case of faculty produced electronic journals perhaps they will. But in the case of those commercially produced, there is no more guarantee that the savings will mostly end up reducing subscription prices than the substantial savings from the automated assembly of personal computers will mostly end up reducing their purchase prices.

Reviews of Mathematical Software

Linear Programming

*Reviewed by Raymond F. Smith**

Those of us interested in using computers in the college classroom often find ourselves restricted to three options: There is a considerable amount of drill-and-practice software which is probably more appropriate in the high school environment. One may make use of sophisticated programs like *Maple* or *Mathematica* which require a considerable amount of work to learn and use. Or one can adapt existing software to a mathematical use (e.g. using a spreadsheet to demonstrate Euclid's algorithm). It is less common to use a program designed by mathematicians for use in a college mathematics class. *Linear Programming by Fractions* (LPBF) is such a program. Written by Paul E. Hodges and Edward N. Willman of the University of Texas Permian Basin, it runs on Macintosh II, SE, Plus or 512 computers. Designed to work in the style of the tableau used when doing linear programming problems by hand, the program does all of its work in fractions, emulating the style which we teach our students. As such it seems to be an ideal program for use by beginners in linear programming. In this review, I will describe the program, comment on the documentation, and make a few suggestions for improvement.

Using the Program

As the program starts, the user is asked to indicate the sign convention to be used for the objective function (i.e. whether negative values indicate profits or losses). The next option is whether data is to be input from a previously saved LPBF file or the keyboard. In the former case, the user opens the file in the usual Macintosh style. In the latter, the user is asked for the number of structural

variables and the number of constraints. The maximum number of variables is 54, while there can be up to 18 constraints. Thus any problem that one would reasonably want to do in a classroom setting can be handled. The next stage is to describe the constraints and variables. The user determines the nature of the inequality for each constraint, and may assign a name to the constraint. There is also an option to name the objective function and the structural variables. Once this is done, the user gives the values for the coefficients. Values are entered as integers or fractions.

When the input is complete, the program introduces the necessary artificial variables and displays the tableau in the standard format. At this stage it is possible to edit coefficients as well as the various names. Rows and columns may be added, but not deleted, and the changes may be saved. Once the entries are correct, the fun begins.

The most interesting way to use the program is to mimic doing the simplex method by hand. You can pick a potential pivot element by clicking on it. The element is shown as the intersection of a shaded row and column. The ratio of this element with the right-hand side is shown at the bottom of the screen. Thus the user can check all potential pivots, and decide which to use. Once the pivot is selected, pivoting is accomplished by simply hitting Return. The new tableau shows up almost instantly. Since all of the arithmetic is done with fractions, it is easy for the user to see what has happened. Ratios, though, are shown as decimals, so that it is easy to compare them.

Once the user thinks that a solution has been reached, it may be checked by first using "Restart" (under the "File" menu) and then selecting "Find Optimal Solution" under the "Compute" menu. It is also possible to look at the solution, objective function, and right hand side in tabular form by using the appropriate menus. All of these tables as well as the tableau may also be printed. Another useful feature is that the user may return to the original tableau and change coefficients to observe the effect of these changes. The current tableau may be saved at any time using an option in the "Edit" menu.

I worked through several examples, and found the program to be as easy to use as I have described above. The arithmetic was always correct, the display of large fractions (up to 19 characters) excellent, and the entire tableau easy to read (See graphic on next page).

Documentation

The documentation is simple and easy to understand, and befits this program. The tutorial section leads the user through sample problems, providing all that is needed in order to use the program. Additional short sections provide notes on program limitations and references.

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short, the documentation is well-written, and should be a model for those who write programs for the mathematical community.

Concerns

My concerns are minor, and focus around the conversion of this program to Macintosh format. In most cases, the authors have done an excellent job, but there are a few features that would make it a better Macintosh program. The most significant is that if the user double-clicks on the icon of a saved LPBF file, only the program opens; you still have to go through the process of opening the file. Other problems include inconsistency in using radio buttons, "Cancel" dropping the user out of the program rather than returning to the previous level, and a use of menus that is inconsistent with Macintosh standards. I want to emphasize that these are minor quibbles,

but they should be addressed in a new version of the program. An option that might be useful would be to allow input of data from other formats. For example, it might be more convenient to create the coefficients in a spreadsheet, save them to a text file, and open the text file within LPBF.

Summary

This program is a fine addition to the collection of software designed for use in the mathematics classroom. It works flawlessly. Its use of Macintosh graphics is excellent. The approach it uses is pedagogically sound; the student has to think, not do ugly calculations. The flaws I found represent minor inconveniences, at most. I would strongly recommend *Linear Programming by Fractions* to anyone teaching an introductory course in linear programming.

File RHS OBJ Solution Tableau Compute Edit Insert

Linear Programming By Fractions

1/2	1	1/6	0	10
3	0	-1/3	1	12
-8	0	4	0	240

Phase 2: Basic Feasible Solution

Column Variable: BENCHES
Row Variable: SLACK FINISHING

Ratio With RHS: 4.0000
Ratio With OBJ: -2.6667

Inside the AMS

Report of the Secretary

Robert M. Fossum

Meetings

The Annual Meeting of the Society in 1989 was held in Phoenix, Arizona. The Colloquium Lectures were delivered by Nicholas Katz. The Gibbs Lecture was given by Elliott H. Lieb. There were seven Invited Addresses and four AMS-MAA Invited Addresses. There were thirteen Special Sessions and many sessions for contributed papers. A feature of the meeting was the AMS-MAA Presidents' Concert with William Browder, President of AMS, on the flute and Leonard Gilman, President of MAA, at the piano.

The 1989 Summer Meeting of the Society was held in Boulder, Colorado in August. William P. Thurston was the Colloquium Lecturer. This meeting marked the inauguration of a new lecture series called Progress In Mathematics. These lectures will provide a forum for the exposition of mathematical topics that have come into prominence in the last five years. The speakers are assigned a general topic and are not obligated to speak on their own research. The first two Progress Lectures were given by Haim Brezis and Dusa McDuff. There were two Invited Addresses, five Special Sessions, and numerous sessions for contributed papers. On the occasion of the 75th Anniversary of the founding of Pi Mu Epsilon, Inc (PME), the national mathematics honorary society, there was an Invited Address sponsored by the Society, the MAA, and PME delivered by Joseph P. Gallian. There were four AMS-MAA Invited Addresses.

A feature of Annual and Summer Meetings is the awarding of prizes. At the Annual Meeting in Phoenix in January 1989, the 1989 Bôcher Prize was awarded to Richard M. Schoen of Stanford University for his work on the application of partial differential equations to differential geometry. This prize honors Maxime Bôcher who was the Society's second Colloquium Lecturer and tenth President. It is awarded every five years for a notable research memoir in analysis.

The Leroy P. Steele Prizes for 1989 were awarded at the Summer Meeting of the Society held in Boulder. The 1989 Steele Prize for Expository Writing went to Daniel Gorenstein for his book *Finite Simple Groups, An Introduction to their Classification* and two survey articles. The 1989 Steele Prize for a Fundamental Paper went to Alberto P. Calderón for his paper *Uniqueness in the Cauchy Problem for Partial Differential Equations*. The 1989 Steele Career Prize was awarded to Irving Kaplansky for his lasting impact on mathematics, particularly mathematics in America.

There were five sectional meetings of the Society in 1989 at which twenty Invited Addresses were delivered and thirty-seven Special Sessions were held. The Society has begun to display its books and journals and to demonstrate its Mathematical Reviews database retrieval system (MathSci) at sectional meetings.

The Society will hold a joint meeting with the London Mathematical Society in Cambridge in the summer of 1992. The format will be similar to the Society's sectional meetings, with several Invited Addresses and Special Sessions as well as sessions for contributed papers. Details will, of course, appear in *Notices*. Dates can be found on the inside of the front cover.

Finally a resolution has been found to a long standing debate within the Society as to whether to continue to hold summer meetings. The Executive Committee, the Board of Trustees and the Council have all agreed to continue these summer meetings, which are held jointly with the Mathematical Association of America. The 75th Anniversary of the founding of MAA will be celebrated in Columbus in August of 1990 at a joint Summer Meeting. Then the two organizations will meet together in Orono, Maine in August 1991. A site for the August 1992 meeting is yet to be determined. But it has been decided to hold a meeting in August 1993 in Vancouver, British Columbia, jointly with MAA and the Canadian Mathematical Society.

The Society sponsored, jointly with the Society for Industrial and Applied Mathematics (SIAM) and the Institute for Mathematical Statistics, eight Joint Summer Research Conferences in the Mathematical Sciences.

sponsored, together with SIAM, the 1989 Summer Seminar in Applied Mathematics. It sponsored the 1989 Summer Research Institute on Several Complex Variables. And it sponsored, with support from the National Science Foundation, Duke University, and the University of Utah, a Symposium on Complex Geometry and Lie Theory.

Publications

1989 was the first year of operation of the Editorial Boards Committee (EBC). This is a committee of the Council that makes recommendations to the Council of members of the various editorial boards. The method by which these editorial boards members were chosen was changed in the election of 1988. From the perspective of the Secretary, the EBC has worked very effectively.

The Council in 1989 established several new book series. A book series titled *Advances in Soviet Mathematics* and a series *Proceedings of Regional Conferences in the USSR* were established to continue the Society's program of publishing Soviet mathematics. The book series *History of Mathematics* became a joint venture with the London Mathematical Society. And the *Collected Works* book series was established so that the Society could begin a program of publishing collected works of mathematicians.

Notices received a good amount of attention by the various governing bodies of the Society. The age old problem of how to deal with letters to the editor of *Notices* arose again. The Committee on Science Policy and the Council recommended the creation of a Forum section for longer opinion pieces. And the Council requested that all election material should appear in *Notices* before ballots are mailed. As a contrast to this increase in the material to be published, the Board of Trustees became alarmed at the number of pages published (and therefore the cost). It should be remarked that *Notices* is not a revenue-generating journal, but it is the journal of record of the Society.

In order to decrease the period from submission to publication of letters to the editor and to eliminate the bureaucracy involved in the decision making, the Notices Editorial Committee (NEC) agreed to name one of its members as a Letters Editor. This editor is responsible for making all decisions regarding publication of letters (while still accountable to the whole committee). After agreeing to establish a Forum section in *Notices*, the NEC also named one of its members as a Forum Editor and charged that editor with the responsibility for this section.

The NEC considered many cost saving suggestions made by the Interim Managing Editor and the Managing Editor. These included eliminating much of the white space and printing some items in smaller type. The reduction in production costs realized by the NEC are

still considered not to be sufficient. And increasing demands for space in *Notices* will continue to drive up the costs of producing the journal. Efforts to contain, and possibly reduce, these costs are continuing.

Related to the question of publication of letters to the editor of *Notices* is the issue of responses to reviews of books published in the *Bulletin*. One unpublished and one published review and the concomitant controversy caused the Council to consider the question as to whether the *Bulletin* should permit publication of alternative reviews or responses. The Council has sent the question to its Editorial Boards Committee for further consideration. This story has not ended.

Society Business

The Society enjoyed a good year financially. The Future Operations Fund now stands at \$6,115,000 which is about 34% of the annual operating budget. More about the Society's finances can be found in the Annual Report of the Treasurer in this section.

At the end of 1989, there were 26,810 individual members in the Society.

The Council of the Society considered how the Society elects its officers. One result of this consideration was a Council decision to conduct contested elections for the Presidency (more precisely for the President-Elect position). The method by which this election will be conducted was also determined. The Council will instruct its Nominating Committee to present two candidates for election to the position of President-Elect. For each candidate, the Nominating Committee will suggest a Nominator who will have the task of writing an article of nomination to appear in *Notices* shortly before ballots are mailed. The Council requested that biographies and statements by candidates for other positions also appear in *Notices*. In order to have all this material ready for publication, the nominating process has been moved forward by several months. Requests for Nominations by Petition for the election in a given year will begin to appear in *Notices* in November of the preceding year. It is planned that the Council will be finished with the nomination process by its spring meeting. The first election to which these modifications will apply will be that of 1991. The Council has requested a report on contested elections after three elections have been held.

The Council is also considering other modifications to the election process. Some of these will appear on the 1990 ballot as suggested amendments to the Bylaws. It should be noted that contested elections for the presidency does not require a change in the Bylaws.

The Society awarded three AMS Centennial Fellowships for 1989. The recipients were Isaac Efrat of Columbia University, John M. Lee of the University of Washington, and Ralph Spatzier of the State University of New York at Stony Brook.

The Council established two types of awards for public service by mathematicians. The first is called the Award for Distinguished Public Service and is to be presented every other year to a research mathematician who has made a distinguished contribution to the mathematics profession through public service. The second is called the Citation for Public Service and is to be presented for notable contributions to the profession through public service.

Science Policy

The Committee on Science Policy (CSP) has continued its active role in formulating policy within the Society. Many actions that are reported above were first suggested by this committee. Such items as the Forum section of *Notices* and the public service awards were suggested first by the CSP.

Education

The Society continues to examine its role in mathematics education. In 1989 it was asked and agreed to support the National Council of Teachers of Mathematics' "Curriculum and Evaluation Standards for School Mathematics". Various members of the Society have active roles in the leadership of the Mathematical Sciences Education Board and Board on Mathematical Sciences as well as MS2000 (a project under the direction of these Boards). These members keep the Council and the Science Policy Committee informed of activities in this area.

Joint Policy Board for Mathematics

The Joint Policy Board for Mathematics (JPBM) is a cooperative venture sponsored by the Society, the MAA, and SIAM. One of its major activities has been to direct its Office of Governmental and Public Affairs (OGPA) in Washington, DC. When Kenneth M. Hoffman moved from the position as Head of OGPA to become Executive Director of the Mathematical Sciences Education Board, JPBM instituted a search for a new Director of OGPA. Late in 1989 the Board of Trustees of SIAM withdrew its (financial) support from various activities of OGPA (while still supporting membership in JPBM). The ECBT and, subsequently the Council, agreed to continue to support the OGPA in cooperation with MAA. This action by SIAM resulted in a delay in the search for a Director. (As this is being written, this search appears to be coming to a fruitful conclusion.) In the interregnum the office has been under the excellent directorship of Alfred B. Willcox.

The officers of the Society believe that support by SIAM for OGPA is an extremely important component of the office. They have left the door open by inviting SIAM to re-institute its support of this activity. This story also lacks an ending.

Report of the Treasurer Franklin P. Peterson

I. Introduction

The American Mathematical Society ended the decade of the 80s with a year of a moderate surplus and a strong financial condition. I have previously described the magnitude of the losses reported during the early part of the decade. During that period (1980-1984), the Society incurred losses totaling \$2,548,000. On December 31, 1984, the Society's fund balances (excluding endowments) had declined to \$1,688,000, or 18% of the Society's total assets (excluding endowments) of \$9,555,000. On December 31, 1979, fund balances were 44% of total assets (excluding endowments) of \$6,891,000. After 1984, the Society experienced several good years of earnings, and at the end of 1989, the Society's fund balances (excluding endowments) had increased to \$9,382,000 or 46% of total assets (excluding endowments). Included in these fund balances is the Future Operations Fund. The Long Range Planning Committee and the Board of Trustees have recommended that the Society build this fund to an amount equal to one year's operating budget. On December 31, 1989, the Future Operations Fund was \$6,114,000 about 41% of one year's budget.

The recent improvement in the Society's financial health can be only partially attributed to cost cutting and fiscal restraint. The Society's finances are very greatly affected by the general economy, library budgets, and even foreign exchange rates. These and other factors are very difficult to predict and the Society often finds itself in the position of reacting to these factors. 1989 saw the beginnings of a slowdown in the economy. State governments (particularly in the northeast) are experiencing financial difficulties, and these problems have been reflected in the budgets of state educational institutions and their librarians. Institutions are now applying pressure on publishers to keep journal prices low; as librarians begin to make choices among an ever increasing number of journals, attrition in subscribers to AMS journals is likely to increase. The Future Operations Fund is an attempt to prepare for the inevitable deterioration in these environmental factors.

II. Summary Financial Statements

The Treasurer this year again presents to the membership summary financial statements of the Society. A copy of the Society's audited financial statements, as submitted to the Trustees and the Council, will be sent from the Providence Office to any member who requests it from the Treasurer. The Treasurer will be happy to answer any questions members may wish to put to him concerning the financial affairs of the Society.

SUMMARY STATEMENT OF ACTIVITY

For the Year Ended December 31, 1989
(Thousands of Dollars)

Revenue	\$ 9,360	60%
Journals	1,682	11%
Books	1,411	9%
Dues	270	2%
Membership Activities	423	3%
Meetings	953	6%
Grants and Contracts	987	6%
Investment Income	658	4%
Other	\$15,744	101%
Total revenue		
Expense	\$ 8,113	55%
Journals	1,723	12%
Books	418	3%
Marketing	370	2%
Membership Records	304	2%
Membership Activities	628	4%
Meetings	1,139	8%
Grants and Contracts	548	4%
Software Development Projects	662	4%
MR Database Development Projects	946	6%
Other		
Total expense	\$14,851	100%
Excess of Revenues over Expenses	\$ 893	

SUMMARY BALANCE SHEET

December 31, 1989
(Thousands of Dollars)

Assets	
Cash and temporary investments	\$ 4,397
Other short-term investments	306
Receivables - members and others (less allowance for doubtful accounts)	972
Deferred prepublication costs	845
Inventory of completed books and back volumes of journals	1,231
Prepaid expenses and deposits	875
Property and equipment (less accumulated depreciation)	5,284
Total operating assets	13,910
Long-term investments (unrestricted)	6,289
Total operating assets and unrestricted investments	20,199
Long-term investments (restricted)	2,164
Total assets	\$22,363
Liabilities and fund balances	
Accounts payable	\$ 1,085
Subscriptions, dues, and other revenues received in advance	8,520
Other miscellaneous liabilities	1,212
Total liabilities	10,817

Unrestricted fund balances:	
Operating fund balance	3,093
Unrestricted investment fund balances:	
Future operations	6,114
Friends of Mathematics	124
Other	51
Total unrestricted invested funds	6,289
Total unrestricted fund balances	9,382
Restricted invested fund balances:	
Endowment funds:	
The Endowment Fund	100
Robert Henderson	548
Joseph Fels Ritt	23
Prize funds	169
Waldemar J. Trjitzinsky	189
Centennial Research Fellowship	1
Pooled Income Fund	5
Eliakim Hastings	3
Undistributed net gains on investment transactions	1,126
Total restricted invested funds	2,164
Total liabilities and fund balances	\$22,363

III. Operations

I now turn to a discussion of the Society's 1989 operations.

Journals. Journals provide the largest fraction of the Society's revenues and expenses. In the past, journals have operated at a net loss. Since 1985, journals (in the aggregate) have operated in the black and provided a very significant portion of the Society's surplus (the excess of revenues over expenses in the summary financial statements above). 1989 was the second year of publication of the Journal of the American Mathematical Society. Financially, the Journal operated at about the breakeven level, a remarkable achievement considering it is only two years old. It can be expected that the amount of surplus generated by journals will decrease over the next few years. This is a result of pressure from subscribers to keep prices low, and increases in costs which are largely outside of the control of the Society (postage will increase 20% in 1991, royalties paid on translation journals have recently been increased 25%, to cite two examples). Alternative cost saving opportunities and alternative sources of support are being sought to compensate for the higher expenses.

Books. Included in this category are not only books (monographs or collections of articles) but review volumes and indexes to journals. Books, exclusive of the latter, continue to be financially sound, and selling prices of AMS books compare very favorably with other mathematical books.

Review volumes and indexes have been very costly to produce, resulting in high prices. In 1988, indexes and

review volumes together produced a small surplus. However, in 1989 it became apparent that review volumes were no longer being purchased at the rate at which they once were. In spite of the fact that the prices of the review volumes have been kept artificially low, they have not sold well. As a result, it was necessary in 1989 to "write down" the Society's inventory of these books to an amount more likely to be recovered from future sales. The effect of this accounting adjustment was an increase of expenses charged against review volumes amounting to approximately \$121,500, including overhead and other indirect costs.

Among the remaining books of the Society, there were similar write downs associated with three books. These amounted to approximately \$36,900.

Dues, Membership Activities, and Membership Records. The Society has about 490 institutional members and 24,600 individual members. Of the latter, about 9,000 pay no dues because they are student nominees, emeritus members, or reviewers without convertible currency. Individual member dues are two-tiered to provide some relief to lower paid members. Increases in dues for individual members are set annually by a cost-of-living index.

Costs which can be considered to be partially covered by dues include the cost of maintaining membership records, the deficits of *Abstracts*, *Bulletin*, *EIMS*, *Notices* and the *Professional Directory*, deficits from meetings, including the Employment Register, deficits from MathSci, and the AMS support of the Joint Policy Board on Mathematics.

Meetings. Meetings are operated at an overall deficit, as a service to the mathematics community. To operate at breakeven would require a significant increase in registrations or a decrease in the quality of the meetings. The deficit has been cut from that reported for 1988, but this is because the 1988 deficit was larger than normal due to the more extensive activities which were planned for the Centennial Meeting.

Grants and Contracts. The amount of money available from the federal government has declined substantially over the years. Currently, support is mainly for travel and subsistence for participants in research conferences, institutes, and seminars, plus the Society's cost in preparing and running these conferences. The money received from government agencies is reimbursement only, with no profit to the AMS. The Society also has contracts to perform services for other organizations, and this helps to recover some fixed costs.

Software Development Projects. The primary project included in this group is the development of a system for the management of order fulfillment, customer and membership databases, and related functions. The costs involved include personnel costs, computer usage charges

and other indirect costs. This is intended to benefit all of the publications and membership related activities of the Society.

MR Database Development. This is another software development project. It is a rewrite of the MR database which is used for the management of the information used in the preparation of *Mathematical Reviews* and related publications. Its cost also include personnel costs, computer usage charges and other indirect costs.

Other Revenues and Expenses. The principal components of other revenues and expenses are MathSci (by far the single largest item), T_EX related products, and the AMS support of the Joint Policy Board on Mathematics.

IV. Assets and Liabilities

So far, this report has dealt with sources of revenue and applications of expense. Another aspect of the Society's finances is what it owns and owes, or its assets and liabilities, which are reported above in the Summary Balance Sheet. The Society maintains its accounts in fund groups. The operating funds include membership and publications activities; the invested funds include both endowment funds (gifts and bequests whose principal is required to be invested in perpetuity and whose income must be used for the purpose stated by the donor) and quasi-endowment funds (those funds set aside by the Board of Trustees for designated purposes). Most of the quasi-endowment funds have been designated for future operations.

The Society's fiscal year coincides with the period covered by subscriptions and dues. Since dues and subscriptions are generally received in advance, the Society reports a large balance of cash and temporary investments on its fiscal year-end, December 31. This amounted to about \$4,703,000 for 1989. The recorded liability for the revenues received in advance was about \$8,520,000 on the same date. The difference can be thought of as having been invested in the Society's other assets. Effectively, the Society borrows from its subscribers to finance current operations. This is a common practice in the publishing industry and allows the Society to maintain a very low amount of bank debt which was zero throughout 1988 and 1989.

The Society's property and equipment include land, buildings and improvements, and office furniture, equipment and software. The Society also owns a small amount of transportation equipment. The land, buildings, and improvements include the Society's headquarters offices in Providence and the Mathematical Reviews offices in Ann Arbor. The appraised value of these facilities currently exceeds \$5,000,000. The largest part of the Society's office equipment is its investment in computer facilities.

Washington Outlook

This month's column is written by Hans J. Oser, who is a consultant to the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics in Washington, D.C.

The 15th AAAS Colloquium on the FY 1991 federal R&D budget, held here on 12-13 April, drew several hundred people wanting to find out what the administration proposes to Congress for federal support in research and development programs for the next fiscal year. While the American Association for the Advancement of Science, organizer of these colloquia, maintains a neutral position above partisan battles, the speakers do not necessarily observe that rule. It is therefore understandable that the President's Science Adviser, D. Allan Bromley, this year's keynote speaker, puts the best spin on the Research and Development package that he helped formulate. He describes the FY 91 R&D budget as a positive sign that the President and his administration strongly support science and technology.

Bromley was very blunt in telling the audience to let Congress know how they felt about their current situation. In a conversation with representatives of the Independent Agencies (including the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Environmental Protection Agency (EPA)), Senator Barbara Mikulski, the chair of the Senate appropriations subcommittee responsible for Veterans Affairs, Housing and Urban Development, related to Bromley that she always hears plenty from veterans, but never from scientists. Some thoughtful letters to the members of the two appropriations subcommittees in the Senate and the House could really do some good (particularly important if a member is from your home State), Bromley suggests. Even though he put the blame on Congress for not getting enough support for principal investigators in this year's budget, he was reminded by the audience that Congress has often given agencies more than what the administration asked for, especially the National Institutes of Health (NIH). It may be quite

appropriate for that reason to let him know also how you feel about your professional environment and what you think could be done to attract the best students into mathematics and science.

It is far more effective to argue for something that is exciting, rather than suggesting somebody else's program be cut. If you feel strongly that something needs to be done to increase the success rate of grants applications in NSF and/or NIH, Senators and Representatives will listen to you carefully. But you will not get very far by questioning the priorities set by Congress (or by the NSF Director for that matter, who after all, is also listening to Congressional demands).

For your information, here are the names of the members of the appropriations subcommittees responsible for the NSF budget:

Senate: Subcommittee on Appropriations for VA, HUD and Independent Agencies, SDOB-142, Washington, DC 20510.

Barbara Mikulski (D-MD), Chairwoman
Patrick Leahy (D-VT)
J. Bennett Johnston (D-LA)
Frank R. Lautenberg (D-NJ)
Wyche Fowler, Jr. (D-GA)
J. Robert Kerrey (D-NB)
Jake Garn (R-UT), Ranking Minority Member
Alfonse M. D'Amato (R-NY)
Charles E. Grassley (R-IA)
Don Nickles (R-OK)
Phil Gramm (R-TX)

House of Representatives: Subcommittee on Appropriations for VA, HUD and Independent Agencies, H-143 Capitol Building, Washington, DC 20515

Bob Traxler (D-MI), Chairman
Louis Stokes (D-OH)
Bill Alexander (D-AR)
Joseph D. Early (D-MA)
Martin Olav Sabo (D-MN)
Bill Green (R-NY), Ranking Minority Member
Lawrence Coughlin (R-PA)
Jerry Lewis (R-CA)

Bromley's staff now includes four Senate-confirmed associate directors at the Office of Science and Technology Policy. He has breathed new life into the Federal Coordinating Council for Science, Engineering and Technology (FCCSET, pronounced "fixit"), by creating a bevy of new committees: Earth and Environmental Sciences; Human Resources and Education; Food, Agriculture and Forest Resources; Science and Engineering; Life Science and Health; Physical, Mathematical and Engineering Sciences; and Technology and Industry.

In the past, FCCSET had no private sector input, consisting entirely of federal laboratory representatives. Now FCCSET has high-level representatives from all federal laboratories and departments. Bromley expects intense interactions between FCCSET and the newly created President's Council of Advisers for Science and Technology (PCAST). PCAST was created on 20 February 1990 and has already met twice with the President. Bromley is also proud of pointing to a vastly different climate within the executive office. He meets regularly with Richard Darman, the OMB director, and sees a cooperation at the top and at staff levels between the two organizations — a considerable improvement over the practice during the past 20 years.

Bromley did express his concern about the decrease in successful grant applications at NIH, which now have dropped below 30% for the first time since the 1950s. He attributes this to NIH having yielded to scientists' pressures to issue larger and longer-term grants, thus leaving less money for new proposals. He promised that in the 1992 budget he will pay special attention to the needs of small science and young investigators. Bromley acknowledged that the threat of the budget deficit will continue to exert pressure on the R&D budget. The President proposes but the Congress disposes, hence the pressure ought be put on Congress.

Bromley is aware that the administration is being criticized for its support of big science projects and for its visceral opposition to anything that resembles an "industrial policy" (a code word for a policy, favored not only by Democrats, by which the government picks certain technologies for federal support, usually intended to strengthen our competitive position in international trade). On industrial policy, Bromley is firm: the Bush administration does not favor that approach. A proper role for the government is to support the development of generic technologies, i.e., those that are broadly applicable in many industries. The federal role is to stimulate the sharing of such technologies and aid in their dissemination. But the administration is better at talking about such a role than getting into action. The Trade Act of 1988 created the Technology Administration in the Department of Commerce. But the first Undersecretary

of Commerce for Technology was sworn in only a short time ago. For its broadened mission, the National Institute for Standards and Technology got a meagre \$5 million this fiscal year, down from \$7.5 million authorized by Congress last year. This means that the nine technology centers planned across the country to assist in bringing new technology to U.S. industry now have to be postponed. This, in spite of the fact that the three centers that now exist in Ohio, South Carolina, and upstate New York have already shown their worth, as reported by Business Week magazine in April.

Biotechnology will play the same role as electronics after World War II, according to Bromley. In this field we are considerably behind Japan in scale-up technology, pointing once again to that nation's ability to turn basic research results into marketable products much more quickly than we do. The administration is grappling with the issue of so-called dual-use technologies. Of the 33 critical technologies that the Defense Advanced Research Projects Agency (DARPA) identified at the request of Congress, about 20 are equally critical to civilian technology and one may ask why those must be supported on national security grounds. Apparently, DARPA stepped over the line drawn by the administration when that agency put money into industries that should have raised capital without government help.

That is the only explanation why Craig Fields, who had been DARPA's director for less than a year, was summarily transferred to another position on 20 April. That transfer, called a "firing" by insiders, is probably based on purely ideological grounds, that Fields was practicing "industrial policy" by investing in so-called dual-use technologies, in this case high-definition television, and for taking an equity position for the government in a small semiconductor materials company in California. Congressional reaction to this demotion has been quite harsh on both sides of the aisle. Dick Gephardt and ten other members of the House have signed a letter calling for Fields' reinstatement, according to press reports.

Bromley also addressed the sorry state of undergraduate education which he characterized as evidence of "appalling ignorance". He firmly believes that the goal set by the Nation's Governors and the President, to make our students best in science and mathematics by the year 2000, is right on the mark. It means to reinvolve parents to give the classroom back to the students, and to provide for adequate teacher training. The best programs must be spread and catalyzed and full attention be paid to the education of women and minorities. Education has resisted the introduction of technology, and our school calendar still provides time off in the summer for "picking berries", he says.

News and Announcements

Michio Kuga 1928-1990

Michio Kuga, Professor of Mathematics at the State University of New York at Stony Brook, passed away on February 14, 1990. He was born in Yokohama, Japan, on May 2, 1928. After receiving his Ph.D. from Tokyo University, he served on its faculty from 1960-1968 rising to Full Professor in 1965. He was visiting member of the Institute for Advanced Study at Princeton in 1961-1963 and again in 1976-1977. He became a permanent resident of the United States in 1966 and served on the faculties of the University of Chicago, Johns Hopkins University, and the University of Oregon before moving to Stony Brook permanently in 1970 where he was a Professor of Mathematics until his death. Professor Kuga was a number theorist in the broadest sense. He made essential contributions to the arithmetic studies of families of Abelian varieties in collaboration with G. Shimura and I. Satake. Despite failing health, he continued working with both students and colleagues in the study of arithmetically defined algebraic surfaces and he initiated a new invariant theory related to the study of Hodge cycles in arithmetic algebraic geometry.

H. Blaine Lawson, Jr.
SUNY at Stony Brook

**National Academy
of Sciences Elections**
At its 127th annual meeting, the National Academy of Sciences (NAS)

announced the election of 60 new members and 15 foreign associates from nine countries in recognition of their distinguished and continuing achievements in original research. Election to membership in the NAS is considered one of the highest honors that can be accorded a U.S. scientist or engineer. This election brings the total number of current members to 1601 and the number of foreign associates to 272.

The NAS is a private organization of scientists and engineers dedicated to the furtherance of science and its use for the general welfare. The Academy was established in 1863 by a congressional act of incorporation, signed by Abraham Lincoln, that calls upon the Academy to act as an official advisor to the federal government, upon request, in any matter of science or technology.

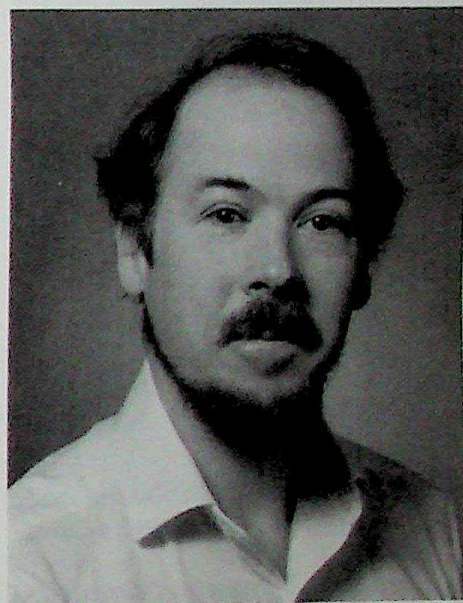
The following mathematicians were elected to the NAS: MICHAEL ASCHBACHER, California Institute of Technology; LAWRENCE D. BROWN, Cornell University; DAVID KAZHDAN, Harvard University; and CATHLEEN S. MORAWETZ, Courant Institute of Mathematical Sciences. LUDWIG D. FADDEEV, Leningrad State University and Leningrad branch, Steklov Mathematical Institute, U.S.S.R. Academy of Sciences was elected a foreign associate.

AMS Centennial Fellowships Awarded

The Society has awarded three Centennial Fellowships for 1990-1991.

The recipients are MICHAEL ANDERSON, SUNY at Stony Brook; CAROLYN GORDON, Washington University in St. Louis; and STEPHEN A. MITCHELL, University of Washington.

SON of the State University of New York at Stony Brook; CAROLYN GORDON of the Washington University in St. Louis; and STEPHEN A. MITCHELL of the University of Washington.



Michael Anderson

MICHAEL ANDERSON received his Ph.D. in 1981 from the University of California, Berkeley under the direction of Blaine Lawson. He worked at Rice University from 1981-1984, at the California Institute of Technology from 1984-1988, and since 1988 has been Associate Professor at the State University of New York at Stony Brook. He was an NSF Postdoctoral Fellow (1984-1986) and has held visiting positions at M.S.R.I., Berkeley; I.H.E.S., France; and I.M.P.A., Rio de Janeiro.

Professor Anderson plans to use the fellowship over the next year to continue research in differential ge-

ometry, especially the study of Ricci curvature and Einstein metrics.

CAROLYN GORDON received her Ph.D. in 1979 from Washington University under the direction of Edward N. Wilson. After spending a year at the Technion-Israel Institute of Technology as a Lady Davis Postdoctoral Fellow and four years at Lehigh University, she returned to Washington University, where she was promoted to Associate Professor in 1987 and to Professor in 1989. She has also been a frequent visitor at the University of Pennsylvania.

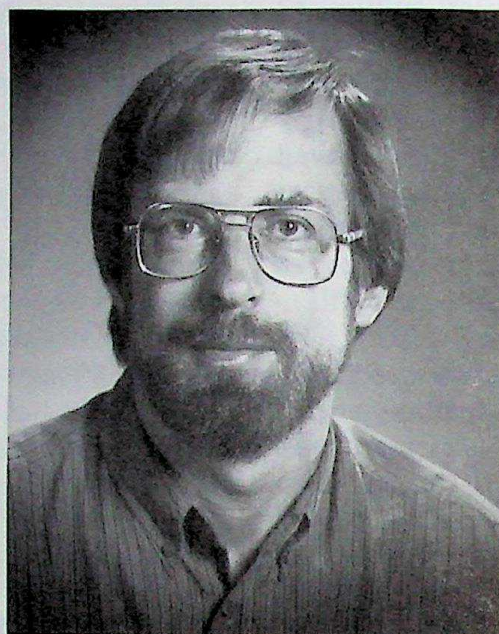


Carolyn Gordon

Professor Gordon's primary research interest is differential geometry, especially eigenvalue problems on Riemannian manifolds and applications of Lie groups to differential geometry. Recently, she has focused on the analogue of the question "Can one hear the shape of a drum?" for closed manifolds.

STEPHEN A. MITCHELL received his Ph.D. from the University of Washington in 1981 under the direction of D.C. Ravenel. He was a Moore instructor at Massachusetts Institute of Technology from 1981 to 1983 and a National Science Foundation Postdoctoral Fellow from 1983 to 1985. He spent the first year of his NSF fellowship at Princeton University and the second at the University

of Washington. He is currently an Associate Professor at the University of Washington.



Stephen A. Mitchell

Professor Mitchell's research interests include stable homotopy theory, the topology of loop groups, and algebraic K-theory.

Information about the competition for the 1991-1992 AMS Centennial Fellowships will be published in the Funding Information for the Mathematical Sciences section of the next issue of *Notices*.

NSF Announces Mathematical Sciences

Postdoctoral Research Fellowships
The Division of Mathematical Sciences of the National Science Foundation (NSF) has offered Mathematical Sciences Postdoctoral Research Fellowships to 28 recent recipients of doctoral degrees in the mathematical sciences.

Awards are made to U.S. citizens or nationals based on their demonstrated ability, and on the significance of career improvement the fellowship would potentially provide. Recipients may choose research environments at fellowship institutions that will best assist them in their scientific development. The Fellowship program is in its eleventh year.

A panel of mathematical scientists, chosen by the American Mathematical Society, the Institute for Mathematical Statistics, and the Society for Industrial and Applied Mathematics evaluated 101 applications. Final selections were made by the NSF.

The stipend of \$66,000 provides support for two nine-month academic years and three two-month summers. Each awardee may choose between two options for receiving the academic year support: as full-time support for any eighteen academic year months in a three-year period, in intervals not shorter than three consecutive months (the Research Fellowship option), or as a combination of full-time and half-time support over a period of three academic years, usually one academic year full-time and two academic years half-time (the Research Instructorship option).

Though Fellowship recipients focus on special project areas, the Fellowship Program also offers advanced training to develop the talent needed to contribute to expanding areas of multidisciplinary research. The Fellowship Program provides opportunities for researchers in mathematical disciplines to expand their interactions with mathematicians in other specialties and with researchers outside of mathematics.

The 1990 recipients are listed below (institutions in parentheses are the current institutions, those outside the parentheses are those at which the fellowship will be held). Two of these awards were jointly supported by the Division of Computer and Computation Research at NSF.

IAN M. ABERBACH (University of Michigan), Purdue University, University of California, Berkeley, R. ADAMS (Stanford University), ROBERT F. ALMGREN (Courant Institute of Mathematical Sciences), Institute of Mathematical Sciences, BONNIE A. BERGER (Massachusetts Institute of Technology), Massachusetts Institute of Technology, JON-

THAN L. BLOCK (Massachusetts Institute of Technology), Courant Institute of Mathematical Sciences; LARRY L. CHEN (Oregon State University), Washington University; ANDREW E. GELMAN (Harvard University), University of California, Berkeley; CHARLES J. GEYER (University of Washington), University of Chicago and University of Minnesota; JOHN T. HAMMOND (University of California, Berkeley), University of Chicago; CHRISTOPHER E. HEIL (University of Maryland and Mitre), Massachusetts Institute of Technology; MICHAEL D. HIRSCH (University of California, Berkeley), University of California, Berkeley; STEVEN A. JANKOWSKY (Harvard University), Rutgers University; GARY S. KATZENBERGER (University of Wisconsin, Madison), University of Virginia; TIMOTHY L. KIEMEL (Cornell University), National Institutes of Health; ERIC P. KLASSEN (California Institute of Technology), Harvard University; BRUCE A. KLEINER (University of California, Berkeley), University of Pennsylvania; JOSEPH M. LANDSBERG (Duke University), University of Pennsylvania and Massachusetts Institute of Technology; TERRY A. LORING (Dalhousie University), University of New Mexico and University of California, Berkeley; JOHN S. LOWENGRUB (Stanford University), Stanford University; JOHN R. MARTINO (Yale University), University of Virginia; ROBERT M. MORELLI (University of Chicago), University of Chicago; ZINOVY REICHSTEIN (University of Pennsylvania), Mathematical Sciences Research Institute; JOHN T. ROMPEL (Massachusetts Institute of Technology), International Computer Science Institute; PETER S. SMEREKA (Courant Institute of Mathematical Sciences), Institute for Mathematics and Its Applications; BURT J. TOTARO (Mathematical Sciences Research Institute), University of Chicago; KEVIN M. WALKER (Mathematical Sciences Research Institute), University of California, San Diego; RICHARD A. WENTWORTH (Columbia

University), Harvard University and Mathematical Sciences Research Institute and DORSHKA C. WYLIE (Massachusetts Institute of Technology), Massachusetts Institute of Technology.

Information about the NSF Mathematical Sciences Postdoctoral Research Fellowship program for 1991 will be published in the Funding Information for the Mathematical Sciences section of a future issue of *Notices*.

Guggenheim Fellowships Awarded

The John Simon Guggenheim Memorial Foundation has awarded 143 fellowships to artists, scholars, and scientists in its sixty-sixth annual competition. The awards, gleaned from 3218 applications, were made on the basis of unusually distinguished past achievement and exceptional promise for future accomplishment. A total of \$3,763,000 will be awarded in this year.

There were four mathematical scientists among the awardees this year. Their names, affiliations, and research areas are: GEORGE BOX, Vilas Professor of Statistics and Director of the Center for Quality and Productivity Improvement, University of Wisconsin, Madison (quality improvement techniques using statistical methods); ROBERT L. CONSTABLE, Professor of Computer Science, Cornell University (the next steps in the implementation of mathematics); IGOR B. FRENKEL, Professor of Mathematics, Yale University (representations of geometric categories); WOLFGANG SCHMIDT, Distinguished Professor of Mathematics, University of Colorado at Boulder (Diophantine equations).

Sloan Foundation Awardees

The Alfred P. Sloan Foundation has announced the names of ninety outstanding young scientists who will receive Sloan Research Fellowships. This year's fellowships, which total \$2.25 million, were awarded from a pool of more than 500 nominations

reviewed by a committee of distinguished scientists.

Now in its 35th year, the Sloan Research Fellowship Program is one of the oldest of its kind in the country. It began in 1955 as a means of encouraging research by young scholars at a critical time in their careers when other support is difficult to obtain. With the current awards, the program has spent a total of nearly \$55 million for support of over 2500 young researchers.

The grants of \$25,000 each for a two-year period are administered by each fellow's institution. The fellows, once chosen, are free to pursue whatever lines of inquiry most interest them, and they are permitted to use the fellowship funds in a wide variety of ways to further their research.

The twenty Sloan Fellows in the mathematical sciences are: JEFFREY DAVID ADAMS, University of Maryland; SIGURD B. ANGENENT, University of Wisconsin; RANEE KATHRYN BRYLINSKI, Pennsylvania State University; LUIS CASIAN, Ohio State University; KEVIN CORLETTE, University of Chicago; WILLIAM DUKE, Rutgers University; PAUL G. GOERSS, University of Washington; ALAN T. GREENLEAF, University of Rochester; URSULA HAMENSTADT, California Institute of Technology; THOMAS Y. HOU, New York University; EHUD HRUSHOVSKI, Massachusetts Institute of Technology; CHARLES KNESSL, University of Illinois at Chicago; D. DARREN LONG, University of California at Santa Barbara; JOHN E. LUECKE, University of Texas at Austin; RUSSELL D. LYONS, Stanford University; PETER PETERSEN, University of California at Los Angeles; THEA PIGNATARO, Columbia University; ALICE SILVERBERG, Ohio State University; JOHN R. STEMBRIDGE, University of Michigan; and MARK A. STERN, Duke University.

NSF-NATO Postdoctoral Fellowships Awarded

The National Science Foundation (NSF) has made fifty-five awards

in the NSF-NATO Postdoctoral Fellowship Program. The purpose of the program is to strengthen ties in scientific and technological research between the U.S. and member countries of the North Atlantic Treaty Organization (NATO).

The fellowships allow young U.S. scientists and engineers to study abroad at institutions and laboratories. An NSF survey of those holding the fellowships between 1960 and 1986 shows that 77% of the fellows maintained contact with their overseas associates long after the fellowship ended.

There were three awardees in the mathematical sciences. Their names and doctoral institutions are listed below, together with the foreign institution at which they will use the fellowship. MARK W. GROSS, University of California at Berkeley, University of Paris; KEVIN P. KEATING, University of Michigan, University of Cambridge; SUSAN A. MURPHY, Pennsylvania State University, University of Utrecht.

The application deadline for the next NSF-NATO fellowship competition will be in **early November, 1990**. For more information and application materials, contact: NSF-NATO Postdoctoral Fellowship Program, Division of Research Career Development, Room 630, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-9466.

NSF Graduate Fellowships Announced

The National Science Foundation (NSF) has announced the award of 850 fellowships for graduate study in the natural and social sciences, mathematics, and engineering.

The NSF Graduate Fellowships provide a stipend of \$12,900 per year for three years of full-time graduate study. The fellowships may also be used over a five-year period to permit students to incorporate teaching or research assistantships into their education during periods in which they

are not receiving fellowship stipends. NSF Graduate Fellows may attend any appropriate non-profit U.S. or foreign institution of higher education. In addition to student stipends, the NSF provides an annual cost-of-education allowance of \$6,000 to the institutions in lieu of all tuition and fees.

The 6300 applications submitted in a nationwide competition were evaluated by panelists assembled by the National Research Council. Awards were made in all 50 states, the District of Columbia, Puerto Rico, the Virgin Islands, and Guam, and 355 awards were made to women.

The awards include 56 in the mathematical sciences and 45 in computer science. The recipients in the mathematical sciences are listed below, together with their baccalaureate institutions (in parentheses) and the institutions where they will pursue graduate studies.

ANDREW A. ALLERS (University of Washington), University of Delaware; JEREMY DAVID AVIGAD (Harvard University), University of California, Berkeley; DOUGLAS STAFFORD BARNUM (Princeton University), University of California, Berkeley; URMI BHATTACHARYA (Indiana University), University of Chicago; TOM CHARLES BRADEN (University of Chicago), Harvard University; DANIEL G. BROWN (Cornell University), Harvard University; WILLIAM MICHAEL CAMPBELL (South Dakota School of Mines and Technology), Cornell University; MICHAEL PATRICK CASEY (University of California, San Diego), University of California, San Diego; CONSTANTINE NICHOLAS COSTES (Harvard University), University of Oxford; DAVID JOHN DILLER (University of Dayton), Ohio State University; DANIEL DYNIN (Ohio State University), Massachusetts Institute of Technology; DAVID ALAN EDWARDS (California Institute of Technology), California Institute of Technology; CAVAN CHERN-HSIEN FANG (University of Wisconsin, Madison), University of California, Berkeley;

KENICHI FUTAMURA (Oberlin College), Stanford University; CHRISTOPHER RALPH GENOVESE (Princeton University), University of California, Berkeley; RUVAIN GITTELMAN (Brown University), University of California, Berkeley; DAVID JOSEPH GRABINER (Princeton University), Harvard University; LINDA ELIZABETH GREEN (University of Chicago), University of Michigan; MARK CHRISTOPHER HAASE (Ohio State University), Princeton University; THOMAS AS JEROME HAINES (University of Michigan), Harvard University; JEFFREY WILLIAM HERRMANN (Georgia Institute of Technology), Stanford University; MARGARET J. HOLEN (University of Chicago), Massachusetts Institute of Technology; TIMOTHY MING-JENG HSU (Massachusetts Institute of Technology), Princeton University; DAVID EDWARD HURTUBISE (University of Notre Dame), Princeton University; TYLER JAMES JARVIS (Brigham Young University), Princeton University; HEATHER MARIE JOHNSTON (Massachusetts Institute of Technology), University of California, Berkeley; NETS HAWK KATZ (Rice University), Yale University; PETER GERARD KAUP (University of Cincinnati), University of Washington; DANIEL ABRAM KLAN (Massachusetts Institute of Technology), Massachusetts Institute of Technology; CATHERINE ESTHER KRILOFF (University of Washington), Stanford University; CYNTHIA HSIEH KUO (University of Chicago), Stanford University; PATRICK MORRIS LAHEY (Rensselaer Polytechnic Institute), Rensselaer Polytechnic Institute; PAUL MARTIN LEFELHOCZ (Massachusetts Institute of Technology), University of California, Berkeley; PETER DAVID MILLER (Southern Methodist University), University of Arizona; WILLIAM PHILIP MINICOZZI II (Princeton University), Harvard University; MICHAEL CHARLES MONTE (Rice University), Rice University; CHRISTOPHER JAMES MONTGOMERY (University of Maryland), Princeton University; SPENCER

150 fellowships to minority students of outstanding ability for graduate study in the sciences, mathematics, and engineering. The number of awards in this program has increased 50% over last year.

Each new fellowship provides a stipend of \$12,900 per year for full-time graduate study. An annual cost-of-education allowance of \$6,000 is also provided to the U.S. institution by NSF in lieu of all tuition and fees. Applications submitted by 869 minority students were evaluated by panels of scientists assembled by the National Research Council of the National Academy of Sciences.

NSF Minority Graduate Fellows may attend any appropriate non-profit U.S. or foreign institution of higher education. Three years of graduate study are supported by each fellowship. The fellowships may be used over a five-year period, so students can incorporate teaching or research assistantships into their education during periods in which they are not receiving their fellowship support.

The new Minority Fellows represent 35 states, the District of Columbia, and Puerto Rico. Of the 150 awards, 61 were made to women, and they are distributed among American Indians, Blacks, Hispanics, and Pacific Islanders. There were 41 awards in the behavioral and social sciences, 47 in engineering, 32 in life sciences, 32 in mathematics and physical sciences (including chemistry, physics, and earth sciences).

The 1990 recipients in the mathematical and computer sciences are listed below, together with their baccalaureate institutions (in parentheses) and the institutions where they will pursue graduate studies.

MICHAEL OLIVER AGUILAR (Princeton University), University of California, Berkeley; SAMUEL NADER CAMARGO (University of Andes), Massachusetts Institute of Technology; DAVID GEORGE CARABALLO (Rutgers University), Princeton University; WILLIAM JOSEPH ETIENNE

(University of Delaware), Princeton University; CHARLES LEE ISBELL (Georgia Institute of Technology), Massachusetts Institute of Technology; FRANKLIN ARTURO MENDIVIL (Georgia Institute of Technology), Georgia Institute of Technology; DANIEL EDWARD PEREZ (Wayne State University), University of Wisconsin, Madison; DEENA YVETTE RICHEY (North Carolina Agricultural and Technical State University), Michigan State University; DAVID SILCAN ROMANO (Oberlin College), University of Michigan; CHRISTOPHER LEON STANARD (Georgia Institute of Technology), Georgia Institute of Technology; JEFFREY ALAN THOMAS (Cornell University), University of California, San Diego; DAVID JOHN TORRES (New Mexico Institute of Mining and Technology), Brown University; CAROL LAVERNE WALTERS (Washington University), University of Maryland.

For more information on applying for the NSF Minority Graduate Fellowships, see the December 1989 issue of *Notices*, page 1458.

Fellows Named at National Labs

Oak Ridge and Argonne National Laboratories have awarded two prestigious postdoctoral fellowships, each in honor of a distinguished mathematician associated with the laboratories. ELIZABETH R. JESSUP, assistant professor of computer science at the University of Colorado at Boulder, will be the first Alston S. Householder Fellow at Oak Ridge. BARRY SMITH, who will finish his doctorate at the Courant Institute of Mathematical Sciences this year, will be the 1990 James Hardy Wilkinson Fellow at Argonne.

Jessup received her Ph.D. in computer science from Yale University. In collaboration with Oak Ridge researchers, she will work on scientific problems involving high-performance computing. Specifically, she will focus on the development of algorithms for solving symmetric, tridiagonal eigenproblems that exhibit both

VANCE MUSE (North Carolina State University, Raleigh), North Carolina State University, Raleigh; HIEU DUC NGUYEN (University of Minnesota, Minneapolis), University of California, Berkeley; ROBERT TODD OGDEN (Texas A&M University), Texas A&M University; DANIEL NELSON OSTROV (University of Wisconsin, Madison), Cornell University; JOHN ALBERT OVERDECK (Stanford University), Stanford University; MARK SHIPMAN OVERLEY (Harvey Mudd College), Cornell University; DAVID POLLEN (Harvard University), University of California, Berkeley; KARL EVERETT RUMELHART (Stanford University), Princeton University; DAVID JOHN SCHMITZ, JR. (University of Notre Dame), Harvard University; PETER FRANK SCHULTZ, II (Knox College), Massachusetts Institute of Technology; ELIZABETH CAROL SCHWERER (New York University), Massachusetts Institute of Technology; MARK ROGER SEPANSKI (Purdue University), Princeton University; BROOKE ELIZABETH SHIPLEY (Harvard University), University of California, Berkeley; JOHN STANLEY TILLINGHAST (University of California, Davis), Harvard University; ELIZABETH CLARE HUNKE TROUY (Memphis State University), University of Arizona; MARK EDWARD WALKER (New Mexico State University), University of Wisconsin, Madison; NIKOLAI ISAAC WEAVER (Harvey Mudd College), Princeton University; GLEN THOMAS WHITNEY (Harvard University), University of Chicago; and ANNE MARIE WILKINSON (Harvard University), University of California, Berkeley.

For more information about applying for the NSF Graduate Fellowships, please see the listing in the Stipends for Study and Travel section of *Notices*, December 1989, page 1458.

NSF Awards Minority Graduate Fellowships

The National Science Foundation (NSF) has announced the award of

the high accuracy and the significant large-grained parallelism appropriate for implementation on a distributed-memory MIMD multiprocessor.

Smith's research is in the area of domain decomposition methods. His thesis developed a general framework that has led to optimal and almost-optimal algorithms for two-dimensional linear elasticity problems. Recently, Smith has also collaborated with researchers in Norway on the study of parallel substructuring techniques.

AWM Announces Schafer Prize Winners

LINDA GREEN, a senior at the University of Chicago and ELIZABETH WILMER, a junior at Harvard University, were selected to share the first annual Alice T. Schafer Mathematics Prize sponsored by the Association for Women in Mathematics (AWM). Each will receive a check for \$1000. The prize is given to an undergraduate woman in recognition of excellence in mathematics. The criteria for selection include, but are not limited to, the quality of the nominees' performance in mathematics courses and special programs, an exhibition of real interest in mathematics, the ability to do independent work, and performance in mathematical competitions, if any. The prize is named for Alice T. Schafer, former president and founding member of AWM, who has done so much for women in mathematics throughout her career. This year's selection committee consisted of Lenore Blum (International Computer Science Institute), Chair; Alice Schafer (Marymount University); and Bhama Srinivasan (University of Illinois, Chicago).

Linda Green was described as one of the top undergraduates in the Mathematics Department at Chicago in the last twenty-five years. She began taking graduate courses as a sophomore and has uniformly excelled in them. She also took the Putnam exam in her sophomore year,

finishing in the top 100. In the summer of 1989, she participated in an NSF sponsored Research Experience at Chicago studying harmonic analysis on local fields; her work was considered to be outstanding. Green has also, in conjunction with this NSF program, served as a counselor in the Mathematics Department's program for mathematically talented students from the Chicago Public Schools.

Being the first to win a mathematics prize is not a new experience to Elizabeth Wilmer; she was a major force behind the Harvard undergraduate mathematics team which won the first Society for Industrial and Applied Mathematics competition in mathematical modeling last year. She showed great promise in high school, placed second nationally in the Westinghouse Science Competition with a graph theory project, and placed seventh on the American Olympiad team. Wilmer spent the Fall 1989 semester taking courses in Budapest where she was considered to be exceptionally talented. She also worked last summer at the National Science Foundation's Research Experiences for Undergraduates program at the University of Minnesota and was asked to return. At Harvard, she has taken several graduate courses, and has served as an undergraduate teaching assistant.

Ten exceptionally talented undergraduate women received Honorable Mention: JENNIFER BEINEKE, Purdue University; URMI BHATTACHARYA, Indiana University; HOPE CONCANNON, Valparaiso University; COLLEEN GALLIGHER, University of Dayton; LELA HILL, California State University - Dominguez Hills; JUDY LEAVITT, University of Michigan; JENNIFER MCLEAN, University of Colorado at Boulder; JEANNE NIELSEN, Duke University; NATALIE THURMAN, Southwest Missouri University; ILEANA VASU, Stanford University. In addition, JULIE B. KERR, a freshman at Washington State University, was given special recognition by the Prize Committee because of her out-

standing achievements in mathematics so early in her career.

The Association received forty-three (43) nominations, and was gratified by the response and the high level of achievement of the women studying mathematics around the country. The prize is funded by an endowment with the initial contributions coming from the AWM, the American Mathematical Society, the Mathematical Association of America, and many individual contributors.

The AWM was established in 1971 to serve and encourage women to study and have active careers in the mathematical sciences. The headquarters office functions as a resource center providing information and career materials upon request. For more information contact the executive director, Patricia N. Cross, at Association for Women in Mathematics, Box 178, Wellesley College, Wellesley, MA 02181.

Faculty Enhancement Awards Announced

The National Science Foundation has announced a total of 35 awards in its Undergraduate Faculty Enhancement Program. This program provides opportunities for faculty to participate in national or regional workshops and seminars on recent developments in the disciplines in which they teach.

Approximately 3000 undergraduate faculty will take part in the conferences and workshops supported by the program. The awards cover the cost of instruction, facilities, and in many cases, room and board and a modest stipend. The participants' institutions are expected to cover travel costs.

The following list contains the names and affiliations of the principal investigators on the Faculty Enhancement grants in mathematics and computer science, together with the titles of their projects and the amounts of the grants.

M. B. COZZENS, Consortium for Mathematics and Its Applications, \$69,905; O. N. GARCIA, George Washington University, *Teaching artificial intelligence and expert systems courses: Content and strategies for undergraduate faculty*, \$129,509; D. W. KAMMLER, Southern Illinois University at Carbondale, *Short courses in discrete and continuous Fourier analysis*, \$26,982; K. K. KUBOTA, Kentucky Research Foundation, *Time-shared operating systems in small college instructional environments*, \$107,817; R. M. NAJAR, University of Wisconsin at Whitewater, *Workshop on computational number theory*, \$27,107; G. OWEN, Georgia State University, *Undergraduate faculty workshops in computer graphics and software engineering*, \$90,666; A. PORTER, University of Wyoming, *Enriching discrete mathematics courses with recent developments*, \$79,965; D. L. SYLWESTER, University of Tennessee at Knoxville, *Teaching modern statistical management: Tools and concepts in undergraduate statistics courses*, \$68,784.

For more information on this program, contact: Undergraduate Faculty Enhancement Program, Division of Undergraduate Science, Engineering, and Mathematics Education, Room 639, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-7051.

Rollo Davidson Prize Awarded
The Trustees of the Rollo Davidson Trust have announced the award of the Rollo Davidson Prize for 1990. The prize was awarded to STEVEN N. EVANS of the University of California at Berkeley.

Professor Evans was cited for his work on (i) Gaussian measures over a local field and (ii) Levy processes on a totally disconnected group.

Small Business Innovation Research Awards
The National Science Foundation (NSF) made \$8.4 million in grants

in its Small Business Innovation Research (SBIR) program. One hundred-seventy awards were made to 139 small, high technology firms in 29 states. Under Phase I of the three-phase SBIR program, NSF awarded up to \$50,000 to these companies, selected from 1544 proposals submitted.

Upon completion of Phase I research, projects which appear the most likely to result in economically and socially beneficial products will receive Phase II NSF grants of up to \$250,000 for two years of continuing research. Private investors fund Phase III product development, manufacturing, and marketing efforts. Cumulative private investment, licensing, and subsequent sales resulting from NSF SBIR projects now exceed \$700 million.

Abstracts of the 1989 SBIR Phase I awards, and copies of the 1990 solicitation, will be available about April 15, and can be obtained from: National Science Foundation, Forms and Publications Office, 1800 G St., N.W., Room 232, Washington, DC 20550.

Listed below are those projects receiving Phase I awards in areas related to the mathematical sciences.

Mathematical sciences: Advanced Research and Applications Corp., Sunnyvale, CA, *Three dimensional reconstruction of images of interior objects using x-rays and large area detectors*; Aware, Inc., Cambridge, MA, *Investigations in wavelet analysis and numerical solutions of partial differential equations*; DAINA, Columbia Heights, MN, *High-speed, low-cost workstation for computation-intensive statistics*; ENIG Associates, Inc., Silver Spring, MD, *Calculations of supersonic steady flow*; Sabbagh Associates, Inc., Bloomington, IN, *Mathematical sciences: Adaptive nonlinear inversion algorithms*.

Advanced scientific computing: Scientific Computing Associates, Inc., New Haven, CT, *Software for large-scale numerical calculation using external memory devices*.

Computer and computation research: MCR Technology, Inc., Goleta, CA, *Knowledge representation of the design history of software intensive systems to reduce life cycle costs*; Methodics, Inc., Burbank, CA, *Research on interactive creation of object-oriented software*; Scientific Computing Associates, Inc., New Haven, CT, *Integrating numerical software libraries with an interactive scientific computing environment*; Software Design & Analysis, Inc., Boulder, CO, *Ada quality toolset*; Softworld, Inc., Raleigh, NC, *Computer aided software engineering via constraint propagation*; Topologix, Inc., Denver, CO, *Parallel Fortran analyzer*.

Networking and communications research and infrastructure: Compression Labs, Inc., San Jose, CA, *Compression of proposed U.S. spectrum-compatible HDTV formats for digital transmission at 44 million bites per second*; Datec, Inc., Research Triangle Park, NC, *High performance flexible adaptive filtering peripheral for digital communication system*; Meridian Technology Corp., St. Louis, MO, *Research on a framework for local network resource accounting*.

Information, robotics, and intelligent systems: Advanced Technology & Research Corp., Laurel, MD, *The use of neural networks for programming and control of sensory based robotics*; Advanced Technology Transfer, Inc., Raleigh, NC, *Miniaturized three-dimensional laser range finder for robotic manipulation of industrial objects*; Digital Video Processing, Inc., Rockville, MD, *A sign language based user system interface*; Robicon Systems, Inc., Princeton, NJ, *Integration of knowledge-based systems and neural networks for intelligent sensorimotor control*.

Westinghouse Science Talent Awards

Three mathematics projects and one neuroscience project were among the top ten winners in the Westinghouse Science Talent Search. In addition,

the first place winner, whose project was not in mathematics, plans to study mathematics in college. There were 1431 entries in this prestigious competition, the oldest high school science contest in the country.

The top prize went to MATTHEW P. HEADRICK, 17 years old, of Chicago, Illinois, who earned a \$20,000 scholarship for his project using molecular genetics techniques to isolate for the first time the gene that is necessary for nitrogen fixation in fresh water blue-green algae. Headrick plans to attend either Princeton University or Stanford University and to major in mathematics with a minor in biology. He also plans to work toward a Ph.D. in mathematics, in preparation for work in theoretical physics.

One of the second-place winners of a \$15,000 scholarship was DAVID R. LIU, 16, of Riverside, California. He developed a model of neural networks on a computer to simulate multi-stage visual processing in humans.

Two mathematics projects earned students scholarships of \$10,000. JOSHUA B. FISCHMAN, 17, of Bethesda, Maryland, won fifth place for developing a computer program to investigate certain properties of p -adic continued fractions. ROYCE YUN-TZE PENG, 17, of Rancho Palos Verdes, California, placed sixth for his attempts to determine whether two planar surfaces, each with a smooth edge on a section of its boundary, could be bent without stretching so that two edges could be matched exactly and joined.

ANDREW LINES, 17, of Arlington, Virginia (formerly of Seattle), earned eighth place and a \$7500 scholarship for writing a computer program that solves a minimal surface problem of soap films.

The winners were selected by a panel of eight scientists following interviews designed to evaluate the students' creativity and potential. Of the nearly 2000 winners since the

contest's inception in 1942, two have won Fields Medals, David Mumford of Harvard University, and Paul J. Cohen of Stanford University. In addition, five have gone on to win Nobel Prizes, eight have received MacArthur Foundation Fellowships, and many have been elected to the National Academy of Sciences and the National Academy of Engineering.

New Mathematics Prize Recognizes Women

The AMS announces the establishment of the Ruth Lyttle Satter Prize in Mathematics, to be awarded in odd-numbered years to recognize an outstanding contribution to mathematics research by a woman in the previous five years. The first Satter Prize will be awarded at the Joint Mathematics Meetings in San Francisco in January, 1991.

Joan Birman of the Department of Mathematics at Columbia University donated funds to the AMS in memory of her sister, Ruth Satter, who passed away last year at the age of 66. The income from the funds will be used for the prize.

Professor Satter earned a bachelor's degree in mathematics and then joined the research staff at AT&T Bell Laboratories during World War II. After raising a family, she attended the University of Connecticut at Storrs and received a Ph.D. in botany at the age of 43. She held a postdoctoral position at Yale University and a visiting professorship at Cornell University before taking a position in the biology department at the University of Connecticut at Storrs. Her research on the biological clocks in plants earned her recognition in the U.S. and abroad. Professor Birman wished to establish a prize to honor her sister's commitment to research and to encouraging women in science.

In addition to Professor Birman, the prize committee consists of Linda Keen of Herbert H. Lehman College

of the City University of New York (chair) and Karen Uhlenbeck of the University of Texas at Austin. The committee invites nominations for the mathematical sciences community for candidates for the prize. Nominations should include the candidate's name, affiliation, field of research, and a description of the work for which the prize would be awarded.

Please send nominations to Robert M. Fossum, Secretary of the AMS, Department of Mathematics, University of Illinois, 1409 W. Green Street, Urbana, IL 61801. Nominations must be received by September 30, 1990.

Call for Nominations for AAAS/Westinghouse Award

The American Association for the Advancement of Science (AAAS) invites nominations for the 1990 AAAS Westinghouse Award for Public Understanding of Science and Technology. The annual award, which carries a \$2500 stipend, recognizes scientists and engineers who make outstanding contributions to the popularization of science but do not work professionally in the media.

The award may be given for publishing, broadcasting, lecturing, museum presentation and exhibit design, and other public outreach activities. The 1989 award went to Robert D. Ballard of the Woods Hole Oceanographic Institution, for his creative contributions to public understanding of the partnership between science, technology, and the social sciences.

The 1990 award will be presented during the AAAS Annual Meeting in Washington, DC, 14-19 February, 1991. The deadline for nominations is August 1, 1990. For more information, contact: Patricia S. Curfman, Award Administrator, AAAS Committee on Public Understanding of Science and Technology, 1333 H Street, NW, Washington, DC 20005, telephone 202-326-6600.

Soviet Conference on Rings, Algebras, and Modules

The International Conference on the Theory of Rings, Algebras, and Modules is planned in honor of the 70th birthday of A. I. Shirshov (1921-1981). The conference will be held 21-25 August 1991 in Barnaul, U.S.S.R. About 100 foreign and 300 Soviet specialists will participate.

The conference will feature the following sections: Associative algebras, rings, and modules (including representations of groups and algebras, homological algebra); Nonassociative rings and algebras (including Lie algebras, superalgebras); Ring and module methods in geometry (including algebraic geometry), analysis (including functional analysis), mathematical logic, and combinatorial algebra. There will be 1-hour, 45-minute, and 30-minute lectures. The conference proceedings will be published.

The Organizing Committee for the conference includes: A. I. Kostrikin (chair), E. B. Vinberg, I. M. Gelfand, S. G. Gindikin, V. A. Iskovskikh, A. A. Kirillov, V. N. Latyshev, Yu. I. Manin, A. V. Mikhalev, I. R. Shafarevich, A. L. Shmel'kin (Moscow); A. E. Zalesskii, V. P. Platonov (Minsk); Z. I. Borevich, A. M. Vershik, A. A. Suslin, A. V. Yakovlev (Leningrad); L. A. Bokut, Yu. L. Ershov, M. M. Laurent'ev, Yu. A. Medvedev (secretary), Yu. G. Reshetnyak, I. P. Shestakov (Novosibirsk); V. A. Andrunakievich, V. I. Arnautov, Yu. M. Ryabukhin (Kishinev); Yu. A. Drozd, A. V. Roiter (Kiev); V. N. Remeslennikov, G. P. Kukin (Omsk); Yu. N. Mal'tsev (Barnaul); B. I. Zil'ber (Kemerovo); Sh. A. Ayupov (Tashkent); Kh. N. Inasaridze (Tbilisi); A. S. Dzhumadil'daev (Alma-Ata). Among the non-Soviets on the Organizing Committee are: S. A. Amitsur (Israel); N. Jacobson, S. Mac Lane, K. M. Grimmon, W. S. Martindale, S. Montgomery, M. S. Osborne, L. W. Small (U.S.A.); P. M. Cohn (Great Britain); G. O. Michler, H. Strade (FRG).

Participants from almost all the countries of Europe and South America are expected to attend, as well as participants from Asia. As the administrative center for the Altai territory of the Soviet Union, Barnaul is an ideal place for such a meeting. The conference organizers are planning excursions to unique places of the Altai.

Those wishing to participate in the conference may write to: Organizing Committee, International Conference on Ring Theory in Memory of A. I. Shirshov, Institute of Mathematics, Novosibirsk, 630090, U.S.S.R.

Royal Society Proceedings

The Royal Society will relaunch its prestigious journal *Proceedings A*, which focuses on mathematics and the physical sciences. With John Enderby of the University of Bristol as editor, the journal is being restructured to enlarge its topical coverage and broaden its appeal. The first issue will appear in July, 1990.

The Royal Society has already received many papers of around 15,000 words, but would like to encourage submissions of papers of less than 5,000 words or ten printed pages. Submissions under 5,000 words will be published within three months. Longer papers will be published within six months.

For further information, contact Jonathan Wainwright, Editorial Office, The Royal Society, 6 Carlton House Terrace, London, England, SW1Y 5AG; telephone 01-839-5561, extension 298; Fax 01-930-2170.

ICM-90 Travel Grant Program

Grants awarded by the National Science Foundation (\$200,000) and the National Security Agency (\$10,000) are being administered by the Society for support of U.S. mathematicians attending the International Congress of Mathematicians, Kyoto, Japan, in August 1990. Three hundred thirty-one applications for support were received and reviewed by members

of an evaluation panel chosen from a pool of names submitted by mathematical and statistical societies, and the U.S. National Committee on Mathematics. The panel was chaired by Stephen D. Smith, University of Illinois, Chicago. At their meeting in Louisville in January 1990, the panel recommended awards for travel support to 135 U.S. mathematicians, with an average award of \$1,500. The panel expressed concern at the small number (twenty-two) of women applicants. As over half of the women applicants qualified for awards, the panel would like to encourage women mathematicians to apply for grants of this kind in the future. Of the 135 awards, one third were made to young mathematicians (those within six years of their doctorate).

Assistantships and Graduate Fellowships Information to Appear Earlier

The AMS publication *Assistantships and Graduate Fellowships in the Mathematical Sciences*, which has been published in December, will now appear in October each year. The information on assistantships and graduate fellowships will be based on current academic year information. With many of the deadlines for application to graduate school coming near the end of the academic year, it was felt that earlier publication of this information would better serve the community than later publication of information on the upcoming academic year. For the same reasons, graduate fellowships and postdoctoral study information which previously was published in the December issue of *Notices* will now appear in the October issue.

Workshop for College Faculty

A Workshop for College Faculty on *Using Graphing Calculators and Computer Graphing to Enhance the Teaching and Learning of Precalculus Mathematics and Calculus* will take place immediately after the August 8-11, 1990, Joint Mathematics Meetings

being held on the campus of The Ohio State University. *Notices* originally announced this workshop in the April, 1990 issue (pages 443 and 458); more information is now available. The organizers are Franklin Demana and Bert Waits. It will be held on Sunday and Monday, August 12-13, 1990, at the Holiday Inn on the Lane, 328 W. Lane Avenue, Columbus. There is no charge for the workshop if selected. A limited number of \$100 partial travel expense awards are available from Addison-Wesley Publishing Company. The application deadline is **June 1, 1990**. For application, write to the organizers, Franklin Demana and Bert Waits, 1990 College Workshop, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210.

Funding Information for the Mathematical Sciences *New Program for Women Faculty*

The National Science Foundation has initiated a new program to recognize a number of the nation's most outstanding and promising women scientists and engineers who are engaged in academic research and teaching. The program, entitled Faculty Awards for Women, is designed to facilitate further development of their academic careers, providing grants of up to five years for research-related activities.

Nominations for the awards must be made by a sponsoring institution. To be eligible, nominees must be U.S. citizens, hold

a Ph.D. (or an equivalent degree) in science or engineering, and be tenured but not yet full professors (or the equivalent rank).

The deadline for submission of nominations is **September 1, 1990**. The Division of Research Initiation and Improvement will be coordinating the program in the Foundation; the contact person there is Jean Vanski, 202-357-7552. In addition, the staff of the Office of Special Projects in the Division of Mathematical Sciences would be happy to answer questions about the program (202-357-3453).

MathSci USER GUIDE

Second Edition

This is the second edition of the *MathSci User Guide*, which provides support and documentation for users of MathSci, the online database covering the world's literature in all areas of mathematics, computer science, and statistics. This handy reference will prove invaluable to the many users who now access MathSci online, from tapes, or on compact disc.

The *MathSci User Guide* provides complete instructions on the use of MathSci. Instructions on getting started, descriptions of aspects of the database, sample searches, information on source publications, explanation of the classification schemes, lists of subject words and keywords, and institution codes and addresses are all in this comprehensive manual. In addition, there is a description of how to use the computer typesetting system T_EX to typeset MathSci records directly from the database, and appendices on transliteration of the Cyrillic alphabet and Chinese names, on mnemonics representing mathematical symbols, and on T_EX codes used in MathSci.

The MathSci database is derived from six printed publications, *Mathematical Reviews*, *Current Mathematical Publications*, *Current Index to Statistics*, *Index to Statistics and Probability*, *Computing Reviews*, and the *ACM Guide to Computing Literature*. Making this broad range of information available, the *MathSci User Guide* will prove useful to researchers as well as librarians.

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For Your Information

A Mathematician at AAAS *Alfred B. Willcox*

The American Association for the Advancement of Science (AAAS) held its annual meeting in New Orleans this past February. In the following article, Alfred B. Willcox, Interim Director of the Office of Governmental and Public Affairs of the Joint Policy Board for Mathematics, describes his experiences as a mathematician attending the meeting. The AMS helps to support mathematical activities at the AAAS meetings by contributing to the sponsorship of speakers in mathematical symposia it cosponsors with the AAAS. In addition, the Society has a committee to act as a liaison with AAAS. The AMS believes that strengthening its ties with AAAS helps to create new opportunities for mathematicians to interact with scientists from all disciplines.

In February, I attended the Annual Meeting of the American Association for the Advancement of Science (AAAS) in New Orleans. I decided to observe the meeting closely from the point of view of a mathematician and report on it to my mathematical friends. I have attended many AAAS meetings during the past three decades and have been impressed by two things: the staggering breadth of stimulating sessions for any curious and concerned scientist and the relative absence of mathematicians in attendance. *Why* don't mathematicians attend AAAS meetings in significant numbers? *Should* a mathematician attend AAAS meetings? My task: To answer these questions.

The meeting was long – seven days, if one wanted to participate in all of the mathematics sessions. The planners had made at least one unfortunate scheduling decision. Two excellent mathematics short courses, on chaotic dynamical systems and computer simulation for biomedical scientists, were scheduled for the first day, with the symposia (half-day sessions with 3–5 papers on one theme) with the greatest concentration of mathematics scheduled for the last three days. As far as I could tell, no mathematicians stayed the course. I, too, was not able to spend seven days in New Orleans – would that I could! – so I missed the short courses and

the last day of mathematics. This scheduling “error” may not have been a flaw, however, because the short courses were given for the benefit of non-mathematicians. Indeed, that is a feature of the AAAS meeting which, I believe, is not always well understood. The programs present papers by scientists, and AAAS consistently attracts the best, addressed not to themselves and their specialist colleagues, but to general scientific audiences and even to the general public. I will comment later on how well AAAS succeeds in capturing and enlightening such a broad audience.

For this reason, I found only a handful of mathematicians when I arrived late on February 14. Indeed, I saw only the organizers and presenters of the short courses. They reported that the courses were quite successful, one of them attracting, and holding to the end, over a hundred participants. It was a good day for mathematics in science.

Because I set out to observe mathematics and mathematicians at the meeting, I found the first two days disappointing, even lonely. I saw very few mathematicians, even though I attended most of the sessions in the mathematics and computing strand. The reason was obvious, computing came first in the program, mathematics second. My feeling of community picked up as the meeting progressed, but I still did not see as many mathematicians as I had expected at the mathematics sessions. Where were they?

The answer can be found in the program itself, a 130-page book. The symposia and technical sessions were organized into 24 strands, grouped into three major categories, *Natural Sciences and Technology*, *Social Sciences and Science Policy* (including science education), and *Global Change*. In addition, there were two or three plenary lectures each day by eminent scientists and science policy leaders. The variety was staggering, and the connections with mathematics numerous. At any hour there was something to lure any mathematician not afflicted with tunnel vision away from the sessions specifically labeled “mathematics”.

That was where the mathematicians were, attracted by visions of African Bees, SDI after perestroika, Global

Warming, Cold Fusion, and Surveys of Human Sexuality. That was the way it should be: We talk to the scientists, they talk to us. In fact, I did notice that most of the mathematicians I saw were on the program as speakers or organizers.

Dedicated as I was to mathematics and computing, I missed these broader fields. Even so, I felt my horizons being greatly expanded. A symposium on *Symmetries Across the Sciences* began with a talk on symmetry in mathematics. I worried that the speaker was being too pure and abstract. The second speaker, a physicist, put my mind to rest by being equally mathematical. The four talks did indeed weave a thread of common meaning in our diverse approaches to symmetry. A symposium on *Understanding Computer Viruses* raised my pulse rate. Two sessions on *Computing and Science* showed me how mathematical models and supercomputers dictate the peculiar shape of the engine nacelles of the Boeing 757 that brought me (safely and smoothly) to New Orleans, improve the efficiency of pest control, fight air pollution, and design artificial human joint implants. A session on *Computational and Mathematical Modeling: Oil Production and Water* convinced me that mathematics will help us extract (or, should I say, squeeze) more than the 66% of our oil reserves currently within our grasp. Despite its obvious local interest, that session was poorly attended, perhaps driving home the importance of jazzy titles. A symposium on the *Radon and Penrose Transforms and Tomography* added considerably to my understanding of the CAT scanner and the underlying mathematics. It also informed me that, for this medical miracle, we humans are lucky that our skulls are on the outside, rather than inside, of our brains. A symposium on *Geometry Today* revived my interest in this main lode of mathematics and amazed me with the prowess of interactive computer graphics. Two symposia, on *Mathematical Methods in the Social Sciences* and *Probabilistic Proofs and Their Applications* were, I am sure, equally successful.

I have not mentioned sessions on science education concerns, which, on other occasions, have received a fair share of my attention. I may have erred in not attending several of these symposia, for there were a fair number of attractive ones on undergraduate curriculum reform, access to science for women and minorities, the science talent pipeline for the 1990s, and similar hot topics. One could profitably spend the entire meeting discussing these topics with our scientific colleagues. I didn't this time and am the poorer for it.

Finally, there are the evenings. Ah, the evenings in New Orleans! The AAAS meeting is a stern taskmaster, leaving few gaps for sight-seeing or night life. Evenings are filled with receptions or major plenary addresses. Most meeting registrants pick and choose, as I do, in order to sample some of the after-hours

attractions of a new city. This time, I picked and chose in order to nurse a nagging cold. I did go to hear D. Allan Bromley, the Special Assistant to the President for Science and Technology, whom we missed at the Joint Mathematics Meetings in Louisville. Unfortunately, the same family illness that caused him to miss our meetings forced him to cancel New Orleans. He did send his new Associate Director of Office of Science and Technology Policy (OSTP) for Biomedical Affairs, James Wyngaarden, former Director of National Institutes of Health (NIH), to give his message. It was a strong message, showing that science and education are high on the Bush agenda and that, Congress willing, the President will give science and education a healthy chunk of the money left over after debt service, deficit reduction, and entitlements in FY91. AAAS President, Richard Atkinson, delivered a stirring speech on the human resources crisis that looms for the 1990s if we do not succeed in attracting more of our young scholars, and especially more young women and minorities, into scientific careers. I listened to, and was captivated by, Sally Ride, who spoke eloquently, with some spectacular slides, on monitoring planet earth from space.

My conclusion from these five solidly packed days was that it is well worth any mathematician's time to listen to his or her mathematical colleagues talk to other scientists about what we are doing. Even better, of course, is to do some of the talking yourself, and, best of all, to hear our scientific colleagues talk about what they are doing. Without this kind of cross-fertilization, we are in danger of becoming ingrown and over-specialized. John von Neumann once wrote, "As a mathematical discipline travels far from its empirical source ... it is beset with growing danger. It becomes more and more pure aestheticizing, more and more *l'art pour l'art* ... the stream, so far from its source, will separate into a multitude of insignificant branches... a disorganized mass of details and complexities."

Nothing brings us so close to our sources as the search for common interest with our scientific colleagues. The AAAS meeting is one of the best forums for such discourse. So, my advice to my mathematical colleagues is: Attend a meeting of the AAAS. It will broaden your outlook on mathematics, and it will probably become a habit, a *good* habit.

Postscript. Symposia are coordinated by the AAAS Sections. Section A (Mathematics) sponsors or co-sponsors a dozen or two sessions at a typical meeting. If you are interested in speaking at or organizing a symposium, or if you wish to suggest a topic for a session, write to the Secretary of Section A, Professor Warren Page, New York City Technical College, 300 Jay Street, New York, NY 11201.

1990 AMS Elections

Council Nominations

Vice-President and Members-at-Large

One vice-president and five members-at-large of the Council will be elected by the Society in a contested election in the fall of 1990.

The vice-president will serve for a term of two years effective January 1, 1991. The Council has nominated two candidates for the position, namely:

Chandler Davis

Hans F. Weinberger

The five members-at-large will serve for a term of three years. The Council nominated seven candidates. They are:

David A. Cox

Lesley M. Sibner

John M. Franks

Ruth J. Williams

Kunio Murasugi

Lai-Sang Young

Donald St. P. Richards

The deadline for petitions proposing additional nominations is July 6. Such proposals will not reach the Council for action by mail ballot until after that date.

President's Candidates

Nominating Committee

Three members of the Nominating Committee are to be elected in the fall of 1990 to serve for a term of three years. Continuing members are:

Joan S. Birman

Ray A. Kunze

James E. Humphreys

Alan D. Weinstein

Barbara Lee Keyfitz

Robert Williams

Victor Klee

President William Browder has named three of the six candidates for the other three places. They are:

Henri Gillet

Stephen Wainger

Jerry Lawrence Kazdan

Three additional candidates will be named.

Editorial Boards Committee

Two members of the Editorial Boards Committee are to be elected in the fall of 1990 to serve for a term of three years. Continuing members are:

Linda Keen

Barry Simon

Carlos Kenig

Daniel Zelinsky

President William Browder has named two of the four candidates for the other two places. They are:

Jon F. Carlson

Nolan R. Wallach

Two additional candidates will be named.

Robert M. Fossum
Secretary
Urbana, Illinois

Nominations by Petition

Vice-President or Member-at-Large

Nominations by petition for the positions of vice-president and member-at-large of the Council, in the manner described in the rules and procedures, are acceptable.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions.

Prior to presentation to the Council, petitions in aid of a candidate for the position of vice-president or of member-at-large of the Council must have at least 50 valid signatures and must conform to several rules and operational considerations, which are described below.

Nominating Committee

or Editorial Boards Committee

The name of a candidate for member of the Nominating Committee or the Editorial Boards Committee may be placed on the ballot by petition. The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and operational considerations, described below, should be followed.

Rules and Procedures

Use separate copies of the form for each candidate for vice-president, member-at-large, or member of the Nominating and Editorial Boards Committees.

1. To be considered, petitions must be addressed to Robert M. Fossum, Secretary, P.O. Box 6248, Providence, Rhode Island 02940, and must arrive by 6 July 1989.

2. The name of the candidate must be given as it appears in the *Combined Membership List*. If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the *Notices*. If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate's mailing label or the Providence office.

3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.

4. On the next page is a sample form for petitions. Copies may be obtained from the Secretary; however, petitioners may make and use photocopies or reasonable facsimiles.

5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.

6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the *Combined Membership List* and the mailing lists. No attempt will be made to match variants of names with the form of name in the CML. A name neither in the CML nor on the mailing lists is not that of a member. (Example: The name Robert M. Fossum is that of a member. The name R. Fossum appears not to be.)

7. When a petition meeting these various requirements appears, the Secretary will ask the candidate whether he is willing to have his name on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving his consent.

NOMINATION PETITION FOR 1990 ELECTION

The undersigned members of the American Mathematical Society propose the name of

as a candidate for the position of (check one):

- ☐ **Vice-President**
- ☐ **Member-at-Large of the Council**
- ☐ **Member of the Nominating Committee**
- ☐ **Member of the Editorial Boards Committee**

of the American Mathematical Society for a term beginning 1 January, 1991.

Name and Address (printed or typed)

Signature

Signature

Signature

Signature

Signature

Signature

Columbus Meetings

August 8 – 11, 1990

Supplement to Announcement in April Notices

Please refer to the Preliminary Announcement for this meeting which appears on pages 447-484 of the April 1990 issue of *Notices*. The Table of Contents and Important Deadlines from the preliminary announcement are reproduced below for convenience. The forms for Preregistration/Housing, MAA Minicourses, and the Summer List of Applicants are located at the back of this issue.

Other AMS Sessions

The title of the AMS Committee on Science Policy Panel Discussion to be held on Friday, August 10, at 8:00 p.m. is *Responsibilities of mathematicians in the implementation of the DAVID II Report*.

Other MAA Talks

The title of the presentation to be made by HELAMAN FERGUSON on Thursday, August 9, at 8:00 a.m. is *Theorems in bronze and stone*.

IMPORTANT DEADLINES

AMS Abstracts	
For Consideration for Special Sessions	Expired
Of Contributed Papers	Expired
MAA Poster Session Presentations	Expired
Nominations for MAA Undergraduate Student Papers	Expired
MAA Abstracts	
Of Contributed Papers	Expired
Summer List of Applicants	June 6
ORDINARY Preregistration and Housing	June 6
MAA Minicourse Preregistration	June 6
Motions for AMS Business Meeting	July 10
FINAL Preregistration	July 11
Housing Changes and Cancellations with Housing Bureau	July 16
Residence Hall Package Cancellation (90% refund)	July 16
MAA Banquet (50% refund)	July 31
Sock Hop (50% refund)	July 31
$\pi\mu\epsilon$ Banquet (50% refund)	July 31
Other Changes to Preregistration	July 31
Preregistration Cancellations (50% refund)	August 3

Activities of Other Organizations

The Association for Women in Mathematics Panel Discussion on Thursday, August 9, at 9:00 a.m. is titled *Enrichment programs in urban public schools*. Panelists include HARVEY KEYNES, Talented Youth Mathematics Project; JACQUELINE RIVERS, The Algebra Project; and PAUL J. SALLY, JR., Young Scholars Program.

The AWM Prize Session and Membership Meeting will begin at 10:00 a.m. instead of 10:15 a.m. on Thursday, August 9.

The National Meeting of Department Heads on Tuesday, August 7, at 8:15 p.m. is titled *Curriculum reform—How does a department chair cause it to happen?*. Panelists include THOMAS W. TUCKER, Colgate University; WILLIAM H. JACO, Executive Director of the AMS, and MICHAEL C. REED, Duke University. This session is being sponsored by the **Joint Policy Board for Mathematics (JPBM)** Committee for Mathematics Department Heads.

The title of the Pi Mu Epsilon J. Sutherland Frame Lecture to be given by RONALD L. GRAHAM on Thursday, August 9, at 8:30 p.m. is *Combinatorics and computers: Coping with finiteness*.

MAA Banquet

It was previously announced that MAA members attending the banquet will be recognized by section. Instead it has been decided to recognize members by the year they joined the Association.

WHERE TO FIND IT

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Room and Board Rates

The Room and Board Rates chart which appeared on page 464 in the April issue of *Notices* listed incorrect rates for Children (per person). The correct rates are listed on the chart below.

Food Services

Breakfast serving hours are 7:00 a.m. to 9:00 a.m. on Saturday and Sunday, not 9:00 p.m. as listed in the April issue.

The Ohio State University Room and Board Rates

	Adults* (per person)	Children*† (per person)	2 Adults & 1 Child 6-16 (whole package)	2 Adults & 2 Children 6-16 (whole package)	Children under 6 years **
8/5	\$35 single \$21 double	\$35 single \$21 double	\$65	\$77	\$9
8/6	\$35 single \$21 double	\$35 single \$21 double	\$65	\$77	\$9
8/7	\$35 single \$21 double	\$35 single \$21 double	\$65	\$77	\$9
8/8	\$35 single \$21 double	\$35 single \$21 double	\$65	\$77	\$9
8/9	\$35 single \$21 double	\$35 single \$21 double	\$65	\$77	\$9
8/10	\$35 single \$21 double	\$35 single \$21 double	\$65	\$77	\$9
8/11	\$35 single \$21 double	\$35 single \$21 double	\$65	\$77	\$9

* There can be a maximum of four adults or children per room. They will EACH be charged the double rate per night.

** There is no room charge for children under six years of age; however, there is a full meal charge (per day) for each such child.

† These rates differ from those published in the April issue.

Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

Columbus, OH, August 1990

Joseph G. Conlon	John Morgan
Michael G. Crandall	(Progress in
(Progress in	Mathematics Lecturer)
Mathematics Lecturer)	Michael E. Taylor
Saunders Mac Lane (AMS-MAA)	

Amherst, MA, October 1990

Christopher B. Croke	John J. Mallet-Paret
William M. Goldman	Henry P. McKean, Jr.

Denton, TX, November 1990

Avner D. Ash	John Luecke
Peter S. Constantin	Clarence W. Wilkerson

San Francisco, CA, January 1991

Michael F. Atiyah	Kenneth A. Ribet
(Gibbs Lecturer)	Héctor J. Sussmann
Maria M. Klawe	

South Bend, IN, March 1991

Leonid G. Makar-Limanov	Stephen D. Smith
Donald G. Saari	Deane Yang

Tampa, FL, March 1991

Josefina Alvarez	Michel L. Lapidus
Ronald A. DeVore	Donald St. P. Richards

Fargo, ND, October 1991

Ian D. Macdonald	Sylvia M. Wiegand
Harald Upmeyer	

Invited addresses at Sectional Meetings are selected by the Section Program Committee, usually twelve to

eighteen months in advance of a meeting. Members wishing to nominate candidates for invited addresses should send the relevant information to the Associate Secretary for the Section who will forward it to the Section Program Committee.

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

August 1990 Meeting in Columbus, Ohio

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: Expired

Susan Jane Colley and Gary Kennedy, *Algebraic geometry*
Zita M. Divis and David Terman, *Dynamics of biological systems*

Thomas A. Dowling, Dijen Ray-Chaudhuri and Neil Robertson, *Combinatorics*

Richard K. Guy and Richard J. Nowakowski, *Combinatorial games*

S. K. Jain and S. Tariq Rizvi, *Ring theory*

Surinder K. Sehgal and Ronald Solomon, *Group theory*

October 1990 Meeting in Amherst, Massachusetts Eastern Section

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: July 16, 1990

Colin C. Adams, *Hyperbolic manifolds*

M. K. Bennett and Garrett Birkhoff, *Lattices, geometry, and combinatorics*

Melvyn S. Berger and Robert A. Gardner, *Non-linear dynamics in mathematics and science*

Haskell Cohen, *Semigroups*

William M. Goldman and Bernard Maskit, *Discrete groups and geometric structures in 2, 3 and 4 dimensions*

James E. Humphreys and Ivan Mirković, *Lie groups and algebraic groups*

Chjan C. Lim, *Algebraic graph theory*

V. S. Prasad, *Ergodic theory*

Charles Radin and Marjorie Senechal, *Aperiodicity and order*

November 1990 Meeting in Denton, Texas

Central Section

Associate Secretary: Andy R. Magid

Deadline for organizers: Expired

Deadline for consideration: July 16, 1990

Avner D. Ash and Mark S. Reeder, *Arithmetic groups*

Elizabeth M. Bator, Russell G. Bilyeu and Paul W. Lewis, *Banach spaces-functional analysis*

Ilya Bakelman, *Geometric inequalities and convex bodies*

Scott T. Chapman and Nick H. Vaughan, *Commutative algebra*

Daniel S. Freed, Robert F. Williams and Michael Wolf, *Texas topology and geometry*

Anant P. Godbole, *The probability theory of patterns and runs*

John Luecke and Robert Myers, *Low dimensional topology*

Lisa Mantini and Roger C. Zierau, *Representation theory of Lie groups*

John W. Neuberger and Henry A. Warchall, *Differential equations*

Peter F. Stiller, *Algebraic geometry*

Emil J. Straube, *Several complex variables*

November 1990 Meeting in Irvine, California

Western Section

Associate Secretary: Lance W. Small

Deadline for organizers: Expired

Deadline for consideration: July 16, 1990

Frank Canitto, *Combinatorial groups*

Paul C. Eklof, *Interactions between group theory and logic*

Michael D. Fried and Robert M. Guralnick, *Interactions between group theory and geometry/number theory*

Abel Klein, *Quantum and statistical mechanics*

Bernard Russo, *Operator theory/operator algebras*

January 1991 Meeting in San Francisco, California

Associate Secretary: Andy R. Magid

Deadline for organizers: Expired

Deadline for consideration: September 19, 1990

March 1991 Meeting in South Bend, Indiana

Central Section

Associate Secretary: Andy R. Magid

Deadline for organizers: June 16, 1990

Deadline for consideration: To be announced

March 1991 Meeting in Tampa, Florida

Southeastern Section

Associate Secretary: Joseph A. Cima

Deadline for organizers: June 22, 1990

Deadline for consideration: To be announced

June 1991 Meeting in Portland, Oregon

Western Section

Associate Secretary: Lance W. Small

Deadline for organizers: September 13, 1990

Deadline for consideration: To be announced

August 1991 Meeting in Orono, Maine

Associate Secretary: Lance W. Small

Deadline for organizers: November 15, 1990

Deadline for consideration: To be announced

October 1991 Meeting in Philadelphia, Pennsylvania

Eastern Section

Associate Secretary: W. Wistar Comfort

Deadline for organizers: January 10, 1991

Deadline for consideration: To be announced

October 1991 Meeting in Fargo, North Dakota

Central Section

Associate Secretary: Andy R. Magid

Deadline for organizers: January 25, 1991

Deadline for consideration: To be announced

November 1991 Meeting in Santa Barbara, California

Western Section

Associate Secretary: Lance W. Small

Deadline for organizers: February 7, 1991

Deadline for consideration: To be announced

January 1992 Meeting in Baltimore, Maryland

Associate Secretary: W. Wistar Comfort

Deadline for organizers: April 8, 1991

Deadline for consideration: To be announced

March 1992 Meeting in Springfield, Missouri

Central Section

Associate Secretary: Andy R. Magid

Deadline for organizers: June 26, 1991

Deadline for consideration: To be announced

January 1993 Meeting in San Antonio, Texas

Associate Secretary: Lance W. Small

Deadline for organizers: April 13, 1992

Deadline for consideration: To be announced

August 1993 Meeting in Vancouver, British Columbia, Canada

Associate Secretary: Andy R. Magid

Deadline for organizers: November 11, 1992

Deadline for consideration: To be announced

January 1994 Meeting in Cincinnati, Ohio

Associate Secretary: Joseph A. Cima

Deadline for organizers: April 5, 1993

Deadline for consideration: To be announced

January 1996 Meeting in Orlando, Florida

Associate Secretary: W. Wistar Comfort

Deadline for organizers: April 12, 1995

Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the PCNM from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but can be found in "Rules for Special Sessions" on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the PCNM or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the PCNM at least nine months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to *Notices*, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in *Notices* in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three weeks before the deadline for abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. The processing of proposals for Special Sessions for Sectional Meetings is handled in essentially the same manner as for Annual and Summer Meetings by the Section Program Committee. Again, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer

send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for and organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

**Proposals for Special Sessions to the
Associate Secretaries**

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:

Western Section

Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
Electronic mail: g_small@math.ams.com
(Telephone 619-534-3590)

Central Section

Andy R. Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
Electronic mail: g_magid@math.ams.com
(Telephone 405-325-6711)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
Electronic mail: g_comfort@math.ams.com
(Telephone 203-347-9411)

Southeastern Section

Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
Electronic mail: g_cima@math.ams.com
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special

Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Electronic submission of abstracts is now available to those who use the \TeX typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the abstracts package, users should be sure to specify whether they want the plain \TeX , \AA\MS-TeX , or the \LaTeX package.

Number of Papers Presented Joint Authorship

Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting. An individual may contribute only one abstract by title in any one issue of *Abstracts*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Site Selection for Sectional Meetings

Sectional Meeting sites are recommended by the Associate Secretary for the Section and approved by the Committee of Associate Secretaries and Secretary. Recommendations are usually made eighteen to twenty-four months in advance. Host departments supply local information, ten to twelve rooms with overhead projectors for contributed paper sessions and special sessions, an auditorium with twin overhead projectors for invited addresses, and registration clerks. The Society partially reimburses for the rental of facilities and equipment, and for staffing the registration desk. Most host departments volunteer; to do so, or for more information, contact the Associate Secretary for the Section.

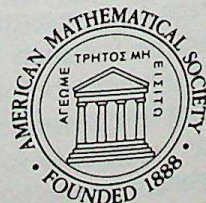
EVERY PLANAR MAP IS FOUR COLORABLE

K. Appel and W. Haken

(Contemporary Mathematics, Volume 98)

In this volume, the authors present their 1972 proof of the celebrated Four Color Theorem in a detailed but self-contained exposition accessible to a general mathematical audience. An emended version of the authors' proof of the theorem, the book contains the full text of the supplements and checklists, which originally appeared on microfiche. The thirty-page introduction, intended for nonspecialists, provides some historical background of the theorem and details of the authors' proof. In addition, the authors have added an appendix which treats in much greater detail the argument for situations in which reducible configurations are immersed rather than embedded in triangulations. This result leads to a proof that four coloring can be accomplished in polynomial time.

1980 *Mathematics Subject Classification*: 05C15
ISBN 0-8218-5103-9, LC 89-15011
ISSN 0271-4132
768 pages (softcover), October 1989
Individual member \$48, List price \$80.
Institutional member \$64.
To order, please specify CONM/98NA



All prices subject to change. Shipment will be made by surface. For air delivery add, 1st book \$5, each additional book \$3, maximum \$100. *Prepayment required.* Order from American Mathematical Society, P.O. Box 1571, Annex Station, Providence, RI 02901-1571, or call toll free 800-321-4AMS (321-4267) in the U.S. and Canada to charge with VISA or MasterCard.

Joint Mathematics Meetings in San Francisco

AMS Special Sessions and Contributed Papers

MAA Contributed Papers

The Joint Mathematics Meetings in San Francisco will be held January 16–19 (Wednesday–Saturday), 1991. The first full announcement of the meeting will appear in the October 1990 issues of *Notices* and *Focus*. This preliminary announcement is made to encourage members' participation and to provide lead time for submission of abstracts for consideration in AMS Special Sessions and for submission of abstracts for AMS and MAA Contributed Paper Sessions.

AMS Special Sessions

It is hoped that the list of Special Sessions for this meeting will be available in the next issue of *Notices*.

Most of the papers to be presented at these Special Sessions will be by invitation; however, anyone contributing an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these sessions should indicate this clearly on the abstract, and **submit it by September 19, 1990, three weeks earlier than the normal deadline for contributed papers**, in order that it be considered for inclusion.

Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940. A charge of \$16 is imposed for retyping abstracts that are not in camera-ready form.

AMS Contributed Paper Sessions

Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive by the abstract deadline of October 10, 1990.** A charge of \$16 is imposed for retyping abstracts that are not in camera-ready form. **Late papers will not be accepted.**

Electronic Submission of AMS Abstracts

This service is now available to those who use the T_EX typesetting system and can be used for abstracts of papers to be presented at this meeting. Requests to obtain the package of files may be sent by electronic mail on the

Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Secretary to Director of Publication, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940. When requesting the Abstracts package, users should be sure to specify whether they want the plain T_EX, A_MS-T_EX, or the L_AT_EX package. Again, late papers will not be accepted.

MAA Contributed Papers

Contributed papers are being accepted on several topics in collegiate mathematics for presentation in contributed paper sessions at the meeting. The topics, organizers, their affiliations, and the days they will meet are:

- *Professional development for teachers of mathematics*, JOHN DOSSEY, Illinois State University, and ELIZABETH J. TELES, Montgomery College, Maryland. Wednesday and/or Thursday.

This session is sponsored by the Committee on Faculty Development (John Dossey, chair). Papers are invited that describe departmental, system, state, regional, or sectional programs aimed at promoting continued faculty growth in mathematics or its teaching. Special consideration will be given to programs which are easily transported from one setting to another. Topics to be discussed can include, but are not limited to, the following: special faculty study programs, focused colloquia series, reading/study groups, teaching improvement programs, and the development and use of technological aids.

- *Statistics and probability*, SHELDON P. GORDON, Suffolk Community College, and FLORENCE S. GORDON, New York Institute of Technology. Friday and/or Saturday.

Contributed papers on any issue relating to statistics and probability courses in the mathematics curriculum are welcome. For instance, 1.) What are some innovative approaches to teaching these courses (such as the use of computers and other technology, simulations, exploratory data analysis or student "research" projects)? 2.) What does statistical literacy mean for liberal arts, science, mathematics, business or social science students? 3.) What statistical ideas are being introduced into the

secondary curriculum and what are the implications for the undergraduate curriculum?

- *Alternatives to the lecture method*, JAMES R.C. LEITZEL, The Ohio State University. Friday and/or Saturday.

This session, sponsored by the Committee on the Mathematical Education of Teachers (COMET), will be devoted to classroom practices which provide alternatives to a strictly lecture approach. Papers are solicited which address strategies and techniques for classroom practice across a variety of topics in the undergraduate curriculum. Presentations which represent large and small class size and upper division as well as lower division courses are desired.

- *Humanistic mathematics*, ALVIN WHITE, Harvey Mudd College and Humanistic Math Network, MARILYN FRANKENSTEIN, University of Massachusetts, Boston, and JOAN COUNTRYMAN, Germantown Friends High School. Wednesday and/or Thursday

Contributions are invited that describe teaching, using, or creating mathematics as a humanistic discipline. The paper should describe the experience and its effect, if any, on the point of view. Philosophical and/or historical papers that contribute to mathematics as a humanistic discipline are also welcome.

- *Lesser known geometrical gems*, DON CHAKERIAN, University of California, Davis, RICHARD PFEIFER, San Jose State University, and JANE SANGWINE-YAGER, Saint Mary's College. Wednesday and/or Thursday

Contributed papers are invited which illustrate interesting but not widely known results which may be used by the teacher to enliven an upper division geometry

course. These may include new insights and forgotten classics in geometry that deserve wider appreciation.

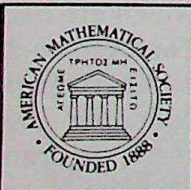
- *Using history in the teaching of mathematics*, DAVID E. ZITARELLI, Temple University. Friday and/or Saturday.

The history of mathematics is used in various ways to enrich and to teach mathematics. Papers in this session should address such uses in courses ranging from liberal arts courses for non-science majors to required courses for mathematics majors. Of particular interest are descriptions of history of mathematics courses, including graduate level courses and those designed for education majors.

Presentations are normally limited to ten minutes, although selected contributors may be given up to twenty minutes. Individuals wishing to submit papers for any of these sessions should send the following information to the MAA Washington office at 1529 Eighteenth Street, NW, Washington, DC 20036 by **September 25**:

1. A page giving the author's name, author's address, the intended session, and a one-paragraph abstract (for distribution at the meeting);
2. A one-page outline of the presentation.

Rooms where sessions of contributed papers will be held are equipped with overhead projector and screen. Blackboards are not available. Persons having other equipment needs should contact the MAA Associate Secretary (Kenneth A. Ross, Department of Mathematics, University of Oregon, Eugene, OR 97403) as soon as possible, but in any case **prior to November 16**. Upon request, the following will be made available: one additional overhead projector/screen, 35mm carousel slide projector, 16mm film projector, or VHS video cassette recorder with a color monitor.



GROUP ACTIONS AND INVARIANT THEORY

A. Bialynicki-Birula, J. Carrell, P. Russell, and D. Snow, Editors
(Conference Proceedings, Canadian Mathematical Society, Volume 10)

This volume contains the proceedings of a conference, sponsored by the Canadian Mathematical Society, on Group Actions and Invariant Theory, held in August, 1988 in Montreal. The conference was the third in a series bringing together researchers from North America and Europe (particularly Poland). The papers collected here will provide an overview of the state of the art of research in this area. The conference was primarily concerned with the geometric side of invariant theory, including explorations of the linearization problem for reductive group actions on affine spaces (with a counterexample given recently by J. Schwarz), spherical and complete symmetric varieties, reductive quotients, automorphisms of affine varieties, and homogeneous vector bundles.

1980 *Mathematics Subject Classifications*: 14-02, 14L30, 1406, 2006; 20G05, 14D25
ISBN 0-8218-6015-1, LC 89-17605
ISSN 0731-1036
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Individual member \$20, List price \$33,
Institutional member \$26
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Symposium on Some Mathematical Questions in Biology

Neural Networks

Vancouver, Canada, August 2-3

The twenty-fourth annual Symposium on Some Mathematical Questions in Biology on *Neural networks* will be held on Thursday and Friday, August 2-3, 1990, during the Congress of the International Union for Pure and Applied Biophysics (IUPAB), July 29-August 3, 1990. The symposium is sponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics (SIAM), and the Society for Mathematical Biology (SMB).

The AMS-SIAM-SMB Committee on Mathematics in the Life Sciences serves as the Organizing Committee for the symposium. The committee at the time this topic was selected consisted of Jack D. Cowan (organizer), Michael C. Mackey, Marc Mangel, Hans G. Othmer, Richard E. Plant (chairman), and John Rinzel.

The theme of the symposium is *Neural networks*. There will be two morning sessions, one on Thursday and one on Friday, August 2 and 3, each session including three one-hour lectures.

For further information, contact the Symposium Conference Coordinator, AMS, P.O. Box 6248, Providence, RI 02940 or by electronic mail: BAV@MATH.AMS.COM.

Applications for the Landahl Travel Awards from the SMB for graduate students to attend this meeting should have been submitted by May 25. See the **Funding Information** section (Landahl Travel Awards) of the April issue of *Notices* for further details.

Program

Thursday, August 2, 9:30 a.m.

Chairman: Robert Miura, University of British Columbia

Neurodynamics. JACK D. COWAN, University of Chicago

Learning, networks, and approximation theory. T. A. POGGIO, Massachusetts Institute of Technology

Neural networks, information theory, and perception in animals and machines. RALPH LINSKER, IBM T. J. Watson Research Center

Friday, August 3, 9:30 a.m.

Chairman: John Rinzel, National Institutes of Health

Learning and generalization in multi-layered neural networks: A statistical analysis. D. RUMELHART, Stanford University

Growing and pruning neural networks: relation to statistical mechanics. ALAN LAPEDES, Los Alamos National Laboratory

Perspectives in computational neurobiology. TERRENCE J. SEJNOWSKI, Salk Institute

American Mathematical Society Short Course Series

Introductory Survey Lectures on

Combinatorial Games

Columbus, Ohio, August 6-7, 1990

Lectures by Elwyn R. Berlekamp, John H. Conway, Aviezri S. Fraenkel, Richard K. Guy, Richard J. Nowakowski, Vera S. Pless.

Final registration deadline July 11, 1990. See April 1990 *Notices*, pages 482-484 for details.

Call For Topics For 1992 Conferences

Suggestions are invited from mathematicians, either singly or in groups, for topics of the various conferences that will be organized by the Society in 1992. The deadlines for receipt of these suggestions, as well as some relevant information about each of the conferences, are given below. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, or telephoning 401-455-4146, or sending E-mail to MEET@MATH.AMS.COM.

Individuals willing to serve as organizers should be aware that the professional meetings staff in the Society's Providence office will provide full support and assistance before, during, and after each of these conferences. Organizers should also note that for all conferences, except Summer Research Conferences, it is required that the proceedings be published by the Society, and that proceedings of Summer Research Conferences are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and the chairman of the Organizing Committee; (2) a one- to two-page description addressing the focus of the topic, including the importance and timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; and (5) a list of likely candidates who would be invited to participate and their current affiliations. Any suggestions as to sites and dates should be made as early as possible in order to allow adequate time for planning. However, proposers of conferences should know that, by action of the AMS Board of Trustees, the Meetings Department of the Society is responsible for the final selection of the site for each conference and for all negotiations with the host institution. Individuals submitting suggestions for the conferences listed below are requested to recommend sites or geographic areas which would assist the Meetings Department in their search for an appropriate site. In the case of Joint Summer Research Conferences in the Mathematical Sciences, a one-, two-, or three-week conference may be proposed.

1992 AMS Symposium in Pure Mathematics

The Symposium in Pure Mathematics has traditionally been conducted in the spring of even-numbered years in conjunction with a sectional meeting. The symposium can be held independently of a sectional meeting and serves to honor great accomplishments in mathematics. Proceedings are normally published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Topics in recent years have been:

1984 – *Pseudodifferential operators and Fourier integral operators with applications to partial differential equations*, organized by FRANÇOIS TREVES of Rutgers University

1987 – *The mathematical heritage of Herman Weyl*, organized by R. O. WELLS, JR. of Rice University.

1989 – *Complex geometry and Lie theory*, organized by JAMES CARLSON and C. HERBERT CLEMENS of the University of Utah.

Deadline For Suggestions: September 1, 1990

1992 AMS Summer Institute

Summer Institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics and usually extend over a three-week period. Dates for a Summer Institute must not overlap those of the Society's summer meeting, which at the time of this printing have not yet been determined. There should be a period of at least one week between them. Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Current and recent topics:

1988 – *Operator theory/Operator algebras and applications*, organized by WILLIAM B. ARVESON of the University of California, Berkeley, and RONALD G. DOUGLAS of the State University of New York at Stony Brook.

1989 – *Several complex variables and complex geometry*, organized by STEVEN G. KRANTZ of Washington University.

1990 – *Differential geometry*, organized by ROBERT E. GREENE of the University of California, Los Angeles, and SHING-TUNG YAU of Harvard University.

Deadline For Suggestions: September 1, 1990

1992 AMS-SIAM-SMB Symposium Some Mathematical Questions in Biology

This one-day symposium, sponsored jointly by the AMS, the Society for Industrial and Applied Mathematics, and the Society for Mathematical Biology, is usually held in conjunction with the annual meeting of a biological society closely associated with the topic. Papers from the symposia are published by the AMS as volumes in the series *Lectures on Mathematics in the Life Sciences*.

Current and recent topics:

- 1987—*Models in population biology*, organized by ALAN HASTINGS of the University of California, Davis.
- 1988—*Dynamics of excitable media*, organized by HANS G. OTHMER of the University of Utah.
- 1989—*Sex allocation and sex change: Experiments and models*, organized by MARC MANGEL of the University of California, Davis.
- 1990—*Neural Networks*, organized by JACK D. COWAN of the University of Chicago.

Deadline For Suggestions: September 1, 1990

1992 AMS-SIAM Summer Seminar

The goal of the Summer Seminar, sponsored jointly by the AMS and the Society for Industrial and Applied Mathematics, is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the AMS as volumes in the series *Lectures in Applied Mathematics*.

Current and recent topics:

- 1987—*Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation*, organized by RANDOLPH BANK of the University of California, San Diego.
- 1988—*Computational solution of nonlinear systems of equations*, organized by EUGENE ALLGOWER of Colorado State University.
- 1989—*The mathematics of random media*, organized by WERNER KOHLER of Virginia Polytechnic Institute and State University and BENJAMIN WHITE of Exxon Research & Engineering Company.
- 1990—*Vortex dynamics and vortex methods*, organized by CLAUDE GREENGARD of IBM T. J. Watson Research Center and CHRISTOPHER R. ANDERSON of the University of California, Los Angeles.

Deadline For Suggestions: September 1, 1990

1992 AMS-IMS-SIAM Joint Summer Research Conferences in the Mathematical Sciences

These conferences, jointly sponsored by the AMS, the Institute for Mathematical Statistics, and the Society for Industrial and Applied Mathematics, are similar in structure to those held at Oberwolfach and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. Topics for the seventh series of one-week conferences, being held in 1990, are: *Probability models and statistical analysis for ranking data*; *Inverse scattering on the line*; *Deformation theory of algebras and quantization with applications to physics*; *Strategies for sequential search and selection in real time*; *Schottky Problems*; and *Logic, local fields, and subanalytic sets*.

If proceedings are published by the AMS, they appear as volumes in the series *Contemporary Mathematics*.

Deadline For Suggestions: February 1, 1991

Call for Topics for 1992 AMS Short Course Series

The AMS Short Courses consist of a series of introductory survey lectures and discussions which take place over a period of one-and-one-half days during the Joint Mathematics Meetings held in January and August each year. Each theme is a specific area of applied mathematics or mathematics used in the study of a specific subject or collection of problems in one of the physical, biological, or social sciences, technology, or business.

Current and recent topics:

Combinatorial games (August 1990), *Mathematical questions in robotics* (January 1990), *Cryptology and computational number theory* (August 1989), *Matrix theory and applications* (January 1989), *Chaos and fractals* (August 1988), *Computational Complexity Theory* (January 1988). Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Applied Mathematics*, with the approval of the Editorial Committee.

Deadline for Suggestions: Suggestions for the January 1992 course should be submitted by **July 1, 1990**; suggestions for the August 1992 course should be submitted by **December 1, 1990**.

Submit suggestions to: James W. Maxwell, AMS, P.O. Box 6248, Providence, RI 02940.

Summer Meeting of the Canadian Mathematical Society

June 1 – 3, 1990

Tentative Program

The Summer Meeting of the Canadian Mathematical Society (CMS) will be held Friday–Sunday, June 1–3, 1990, at Dalhousie University, Halifax, Nova Scotia, Canada.

Scientific Program

Plenary Speakers

The names and affiliations of the speakers, titles (where available), and the days and times they will talk are as follows:

D. P. BERTSEKAS, Massachusetts Institute of Technology, *The auction algorithm for assignment and other network problems*, Friday 9:30 a.m. – 10:30 a.m.

ROBERT L. BRYANT, Duke University, Sunday 9:30 a.m. – 10:30 a.m.

RALPH N. MCKENZIE, University of California, Berkeley, Friday 11:00 a.m. – noon

CLIFFORD TAUBES, Harvard University, *Computing invariants for 4-dimensional manifolds*, Saturday 9:30 a.m. – 10:30 a.m.

Special Sessions

Session I: Universal algebra, MATTHEW VALERIOTE, McMaster University, organizer

RALPH S. FREESE, University of Hawaii, Honolulu, *Free and finitely presented lattices*

GEORGE A. GRATZER, University of Manitoba, *On a proof of Evelyn Nelson*

H. PETER GUMM, SUNY, College at New Paltz, *Lazy data structures*

MARK HAIMAN, Massachusetts Institute of Technology

IVAN RIVAL, University of Ottawa, *Order, invariance and visibility*

M. RODDY, Brandon University, *On a conjecture of G. Bruns*

WALTER F. TAYLOR, University of Colorado, Boulder, *Irreducibility problems in the lattice of interpretability types of varieties*

MATTHEW VALERIOTE, McMaster University, *Varieties having few models*

Session II: Differential geometry, WILLIAM SHADWICK, University of Waterloo, organizer

JOHN S. BLAND, University of Toronto

DENNIS DETURCK, University of Pennsylvania, *Connections with prescribed curvature and Yang-Mills currents*

ROBERT B. GARDNER, University of North Carolina, Chapel Hill, *Exact methods for normal forms in control theory*

NIKY KAMRAN, McGill University

M. KOSSOWSKI, University of South Carolina

IVAN KUPKA, University of Toronto

J. MILLSON, University of California, Los Angeles, *Rational homotopy theory and deformation problems from analytic geometry*

Session III: Topology and global analysis, ANDREW NICAS, McMaster University, organizer

JACQUES C. HURTUBISE, McGill University

H. BLAINE LAWSON, JR., SUNY at Stony Brook

M.-L. MICHELSON, SUNY at Stony Brook

MAUNG MIN-OO, McMaster University

DANIEL RUBERMAN, Brandeis University

C. SIMPSON, Princeton University

Session IV: Optimization, CARL SANDBLOM, Technical University of Nova Scotia, organizer

M. BEST, University of Waterloo

J. DESROSIERS, HEC, Montreal

H. A. EISELT, University of New Brunswick, *Redundancy in randomly generated polytopes*

J. H. HAMMOND, Harvard University

T. L. MAGNANTI, Massachusetts Institute of Technology, *Some applications of computational polyhedral combinatorics*

JONG-SHI PANG, Johns Hopkins University, *Globally convergent Newton methods for nonsmooth equations*

F. SOUMIS, Ecole Polytechnique, Montréal

MILAN VLACH, University of Prague

Session V: Mathematical education, EDWARD WILLIAMS, Memorial University, organizer

Session VI: Contributed Papers

Accommodations

A limited number of residence and hotel rooms are available at conference rates as indicated. Participants should contact the hotel or university residence directly. All the rates are subject to a 10% provincial sales tax. Rooms and rates are subject to availability.

1. University Residence:

Shirreff Hall, Dalhousie University

(free parking, maid service and breakfast)

Telephone: 902-494-2577

Single \$27 Double \$40

2. Hotels:

Lord Nelson Hotel

(1 km from campus on bus route)

South Park Street

Telephone: 902-423-6331

Single or double \$62

Nova Scotian Hilton

(the location of the Canadian Applied Mathematics Society meeting, 2 km from campus, near a bus route)

1181 Hollis Street

Telephone: 902-423-7231 or 1-800-268-7295

Single \$82 Double \$89

Hotel Delta Barrington

(2.5 km from campus, on a bus route)

1875 Barrington Street

Telephone: 902-429-7410 or 1-800-268-1133

Single or Double \$79

Scientific Program Committee: A. DAY, Lakehead University; R. KANE, University of Western Ontario; D. ROLFSEN, University of British Columbia; C. SANDBLOM, Technical University of Nova Scotia; W. SHADWICK, University of Waterloo; and A. THOMPSON, Dalhousie University (Chair).

Local Arrangements Committee: S. SWAMINATHAN, Dalhousie University, Chair

For further information contact: S. Swaminathan, Department of Mathematics, Dalhousie University, Halifax, Nova Scotia, B3H 3H8, Canada, 902-424-3864 or by electronic mail: swami@cs.dal.ca.

Registration Fees

Students	\$ 20
Retired or Unemployed Professors	\$ 20
Non-University Teachers	\$ 20
CMS/AMS/MAA Members without grants	\$100
CMS/AMS/MAA Members with grants	\$160
Non-members without grants	\$120
Non-Members with grants	\$200

ACCESSIBLE CATEGORIES: THE FOUNDATIONS OF CATEGORICAL MODEL THEORY

Michael Makkai and Robert Paré

(Contemporary Mathematics, Volume 104)

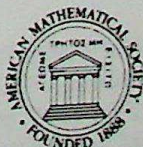
Intended for category theorists and logicians familiar with basic category theory, this book focuses on categorical model theory, which is concerned with the categories of models of infinitary first order theories, called accessible categories. The starting point is a characterization of accessible categories in terms of concepts familiar from Gabriel-Ulmer's theory of locally presentable categories. Most of the work centers on various constructions (such as weighted bilimits and lax colimits), which, when performed on accessible categories, yield new accessible categories. These constructions are necessarily 2-categorical in nature; the authors cover some aspects of 2-category theory, in addition to some basic model theory, and some set theory. One of the main tools used in this study is the theory of mixed sketches, in which the authors specialize to give concrete results about model theory. Many examples illustrate the extent of applicability of these concepts. In particular, some applications to topos theory are given.

Perhaps this book's most significant contribution is the way it sets model theory in categorical terms, opening the door for further work along these lines. Requiring a basic background in category theory, this book will provide readers with an understanding of model theory in categorical terms, familiarity with 2-categorical methods, and a useful tool for studying toposes and other categories.

1980 Mathematics Subject Classifications: 18C10, 03G30, 03C95, 18D05; 18B25, 03E55, 03C75
ISBN 0-8218-5111-X, LC 89-18125, ISSN 0271-4132

184 pages (softcover), December 1989
Individual member \$19, List price \$31,
Institutional member \$25

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Mathematical Sciences

Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

EFFECTIVE with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.

1989–1990. **Academic Year Devoted to Hyperbolic Geometry and Quasiconformal Mappings**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1988, p. 1584)

1989–1990. **Special Year in Geometry**, University of Maryland, College Park, MD. (Dec. 1989, p. 1432)

Spring Term 1990. **Aldo Andreotti Special Semester in Pisa**, Pisa, Italy. (Mar. 1990, p. 324)

1990. **IMACS International Workshop on Massively Parallel Methods in Computational Physics**, Boulder, Colorado. (Sep. 1989, p. 914)

1990. **IMACS Conference on Computer Aided Design**, Yugoslavia. (Sep. 1989, p. 914)

1990. **CWI-IMACS Symposia on Parallel Scientific Computing**, Amsterdam, The Netherlands. (Feb. 1990, p. 216)

1990. **Concentration Year on Stochastic Models, Statistical Methods, and Algo-**

rithms in Image Analysis, Rome, Italy. (Apr. 1990, p. 491)

1990–1991. **Academic Year Devoted to Operator Theory and Complex Analysis**, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1989, p. 1432)

June 1990

June–July 1990. **International IMACS Conference on Mathematical Modelling and Applied Mathematics**, Vilnius, USSR. (Sep. 1989, p. 917)

* 1–3. **Canadian Mathematical Society Summer Meeting**, Halifax, Nova Scotia.

INVITED SPEAKERS: D.P. Bertsekas (MIT), R. Bryant (Duke), R. McKenzie (Berkeley), R. Steinberg (U.C.L.A.), C. Taubes (Harvard).

SPECIAL SESSIONS: Universal algebra, differential geometry, optimization, topology and global analysis, mathematical education.

INFORMATION: G. P. Wright, Canadian Mathematical Society, 577 King Edward, Ottawa, Ontario, Canada K1N 6N5; 613-564-2223.

* 1–4. **A Conference on Algebraic Geometry and Its Applications**, Purdue University, Indiana.

PURPOSE: In honor of teacher and renowned mathematician Shreeram S. Abhyankar, on the occasion of his sixtieth birthday.

INVITED SPEAKERS: Artin, Birkhoff, Eisenbud, Feit, Gorenstein, Igusa, Mumford, Nagata, Seshadri, Buchberger, Chazelle, Costa-Roy, Sederberg, Sweedler, Warren.

INFORMATION: A. Sathaye, Dept. of Mathematics, Univ. of Kentucky, Lexington, KY 40506; Fax: 606-257-4078; tel: 606-257-8832.

14–16. **Sixth Summer Conference on General Topology and Applications**, Long Island Univ. (C.W. Post Campus), Brookville, NY. (Feb. 1990, p. 221)

14–16. **Fifth Southeast Asian Conference on Mathematical Education (SEACME 5)**, Gadong, Brunei Darussalam. (Nov. 1989, p. 1251)

14–16. **Function Estimation and Statistical Applications**, Cornell Univ., Ithaca, NY. (Mar. 1990, p. 328)

* 14–16. **Boundary Value Problems for Or-**

Ordinary Differential Equations, Ohio University, Athens, Ohio.

PURPOSE: The conference will bring together experts working on "Boundary Value Problems" with the purpose of exchanging information and viewpoints relevant to theory and applications. The conference will feature several hour lectures surveying recent advances as well as half hour presentations of research papers.

INVITED SPEAKERS: R.P. Agarwal, Singapore; F.V. Atkinson, Canada; J. Baxley, USA; J. Bona, USA; W. Eberhard, W. Germany; L.H. Erbe, Canada; M. Faierman, S. Africa; P. Habets, Belgium; S. Heikkila, Finland; J. Henderson, USA; H. Kaper, USA; H. Langer, E. Germany; J. Mawhin, Belgium; R. Menniken, W. Germany; A. Mingarelli, Canada; J.J. Nieto, Spain; D. Offin, Canada; R. Ortega, Spain; L. Sanchez, Portugal; R. Schaaf, USA; K. Schmitt, USA; A. Schneider, W. Germany; J. Schroder, W. Germany; J. Serrin, USA; P. Waltman, USA; J. Ward, USA; F. Zanolin, Italy; A. Zettl, USA.

INFORMATION: R. Aftabizadeh, Dept. of Mathematics, Ohio Univ., Athens, OH 45701; 614-593-1268.

14-16. Conference on Scientific Computation on the occasion of Hans J. Stetter's 60th Birthday, Vienna, Austria.

CONFERENCE TOPICS: Ordinary differential equations, partial differential equations, numerical software, validated computation.

INVITED SPEAKERS: G. Alefeld, U. Ascher, G. Bader, K. Balla, M. Bercovier, K. Boehmer, T.D. Bui, K. Burrage, J.R. Cash, P. Deufhard, S. Ola Fatunla, A. Feldstein, B. Ford, J. Herzberger, U. Hornung, P.J. van der Houwen, A. Iserles, Z. Jackiewicz, P. Kaps, H.B. Keller, U. Kirchgraber, U. Kulisch, J.O. Langseth, B. Leimkuhler, C. Lubich, R. Mattheij, G. Micula, M. Nakashima, H. Niederreiter, E.L. Ortiz, A. Pasquali, V.L. Pereyra, F.A. Potra, H. Ratschek, P. Rentrop, E. Russo, J.W. Schmidt, W. Schoenauer, H. Schwetlick, R.D. Skeel, G. Soedler, K. Strehmel, S. Tasan, P.G. Thomsen, H. Wacker, H.F. Wedde, Z. Zlatev.

INFORMATION: C.W. Ueberhuber, Technical University Vienna, Wied-

ner Hauptstrasse 8-10/115, A-1040 Wien, Austria.

15-20. Global Differential Geometry and Global Analysis, Berlin, Federal Republic of Germany. (Jan. 1990, p. 57)

17-23. Partial Differential Equations in Complex Analysis, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

18-20. Joint WNAR-IMS Regional Meeting, Montana State University, Bozeman, MT. (Mar. 1989, p. 315)

18-21. A Conference on Partial Differential Equations, in Honor of Shmuel Agmon, Inst. of Math., Hebrew Univ., Jerusalem, Israel. (Feb. 1990, p. 221)

18-22. Fourteenth Mathematical Sciences Lecture Series on Partially Ordered Sets, Johns Hopkins University, Baltimore, Maryland. (Oct. 1989, p. 1096)

18-22. Approximations Diophantiennes et Nombres Transcendants, Marseille, France. (Jan. 1990, p. 57)

18-23. The Fifth International Conference on Topology and its Applications, Dubrovnik, Yugoslavia. (Mar. 1990, p. 329)

*** 18-23. International IMACS Conference on Mathematical Modelling and Applied Mathematics**, Vilnius, Lithuanian SSR, USSR.

PURPOSE: To bring together scientists in applied mathematics and computational experiment, developers and users of mathematical models from different branches of knowledge for information, ideas and experience exchange.

CONFERENCE TOPICS: Methodology, advanced results in theory and practice of numerical methods and algorithms, nonlinear phenomena modelling, applications of mathematical modelling and computational experiment, stochastic modelling and computational statistics.

INFORMATION: A.P. Mikhailov, Keldysh Institute of Applied Mathematics, USSR Academy of Sciences, Miusskaya pl. 4, Moscow 125047, USSR.

18-26. Recent Developments in H_∞ Control Theory, Villa Olmo, Como. (Feb. 1990, p. 221)

18-29. Radar/Sonar, Minneapolis, MN. (Nov. 1989, p. 1251)

18-29. AMS-SIAM Summer Seminar on Vortex Dynamics and Vortex Methods, University of Washington, Seattle, WA.

INFORMATION: B. Verducci, AMS, P.O. Box 6248, Providence, RI 02940.

20-22. Sixteenth International Workshop on Graph-Theoretic Concepts in Computer Science, Berlin, Federal Republic of Germany. (Jan. 1990, p. 57)

20-23. Second Symposium on Chaotic Dynamical Systems, Conference Center "Woudschoten" (near Utrecht), The Netherlands. (Mar. 1990, p. 329)

21-27. Curves and Surfaces, Chamonix-Mont Blanc, France. (Apr. 1990, p. 494)

24-28. NSF/CBMS Regional Conference on Ergodic Theory and Combinatorial Number Theory, North Dakota State Univ., Fargo, ND. (Apr. 1990, p. 494)

24-30. Mathematische Probleme in der Nichtlinearen Elastizität, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 767)

25-29. International Symposium on Fuzzy Approach to Reasoning and Decision Making, Bochyne, Czechoslovakia. (Oct. 1989, p. 1096)

25-29. Logique et Informatique, Marseille, France. (Feb. 1990, p. 221)

25-July 13. SMS-NATO ASI: Shape Optimization and Free Boundaries, Université de Montréal, Montréal, Canada. (Dec. 1989, p. 1437)

27-29. ACM Conference on Lisp and Functional Programming, Nice, France. (Jan. 1990, p. 58)

27-30. Fourth International Congress on Algebraic Hyperstructures and Applications, Xanthi, Greece. (Apr. 1989, p. 496)

July 1990

July 1990. AMS Summer Research Institute on Differential Geometry, University of California, Los Angeles, CA.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

*** July 1990. Two Week Computer Algebra Course at the Research Institute for Symbolic Computation**, Linz, Austria.

PURPOSE: The course is intended to provide a profound mathematical background for efficient algebraic com-

putations as well as a hands-on-training in using the most advanced computer algebra systems available.

INFORMATION: F. Winkler, Course Director, RISC-Linz Summer School, Johannes Kepler University, A-4040 Linz, Austria.

1-7. **Modulfunktionen In Mehreren Variablen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

1-15. **International Symposium on Algebraic Topology - Adams Memorial Symposium**, University of Manchester, England. (Sep. 1989, p. 918)

1-18. **Twentieth Summer Session on Probability Theory**, Saint-Flour (Cantal), France. (Mar. 1989, p. 315)

*2-4. **Second International Symposium on Databases in Parallel and Distributed Systems**, Trinity College, Dublin, Ireland.

SPONSORS: IEEE Computer Society, ACM SIGARCH, the British Computer Society, the Irish Computer Society, the Office of Naval Research.

PROGRAM COMMITTEE: P. Apers, Twente Univ.; D. Bitton, DB Software; S. Ceri, Politecnio di Milano; U. Dayal, DEC; M. Deen, Keele Univ.; D. Degroot, Texas Instruments; D. Eckland, Intel; A. Elmagarmid, Purdue Univ.; H. Garcia-Molina, Princeton Univ.; G. Gardarin, INRIA; T. Haerder, Kaiserslautern Univ.; H.V. Jagadish, AT&T Bell Labs; M. Kit-suregawa, Tokyo Univ.; R. Krishnamurthy, LIM; P. Larson, Waterloo Univ.; M. Livny, Wisconsin Univ.; W. Litwin, INRIA; D. McGregor, Strathclyde Univ.; M. Missikoff, IASI-CNR; C. Mohan, IBM; E. Neuhold, GMD; A. Reuter, Stuttgart Univ.; G. Schlageter, Hagen Univ.; J. Schmidt, Frankfurt Univ.; D. Shasha, New York Univ.; A. Sheth, Bellcore; W. Staniszkis, CRAI; P. Valduriez, INRIA; K. Wilkinson, HP Research; O. Wolfson, Columbia Univ.; P. Yu, IBM.

INFORMATION: IEEE Computer Society, 1730 Massachusetts Ave., N.W., Washington, DC 20036-1903.

2-6. **Tenth Australian Statistical Conference/Second Pacific Statistical Congress**, Sydney, Australia. (Jul./Aug. 1989, p. 768)

2-6. **The Jónsson Symposium**, Laugarvatn, Iceland. (Sep. 1989, p. 918)

2-6. **Thirty-fourth Annual Meeting of the Australian Mathematical Society**, Townsville, Queensland, Australia. (Oct. 1989, p. 1097)

2-6. **Fifteenth International Biometric Conference**, Budapest, Hungary. (Jan. 1990, p. 58)

2-7. **Groupes Ordonnes et Groupes de Permutation**, Marseille, France. (Jan. 1990, p. 58)

2-10. **Continua with Microstructures**, Villa "La Querceta", Montecatini Terme. (Feb. 1990, p. 222)

2-31. **Time Series**, Minneapolis, MN. (Nov. 1989, p. 1252)

2-August 10. **Représentations des Groupes et des Algèbres de Lie**, Université de Montréal, Canada. (Feb. 1990, p. 222)

3-6. **Eleventh Dundee Conference on Ordinary and Partial Differential Equations**, Dundee, Scotland. (Sep. 1989, p. 918)

5-7. **Lattice Path Combinatorics and Applications**, McMaster University, Hamilton, Ontario, Canada. (Feb. 1990, p. 222)

6-7. **International Colloquium on Applications of Mathematics (on the occasion of the 80th birthday of Lothar Collatz)**, Hamburg, West Germany. (Feb. 1990, p. 222)

8-14. **Variationsrechnung**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

9-11. **"Universita'di Genova - The Ohio State University Joint Conference" on New Trends in Systems Theory**, Genoa, Italy. (Jul./Aug. 1989, p. 768)

9-14. **4ème Colloque International de Theorie des Graphes et de Combinatoire**, Marseille-Luminy, C.I.R.M., France. (Jan. 1990, p. 58)

9-20. **Geometry and Topology of Four-Manifolds**, McMaster University, Hamilton, Ontario, Canada. (May/Jun. 1989, p. 602)

15-20. **SIAM Annual Meeting**, Chicago, IL. (Mar. 1990, p. 329)

15-21. **Stochastic Image Models and Algorithms**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

15-22. **1990 European Summer Meeting (Logic Colloquium '90)**, University of Helsinki, Finland. (Feb. 1990, p. 222)

15-23. **Colloquium in Honor of Roland Fraisse**, Centre International de Recontres Mathématiques, Luminy, France. (May/Jun. 1989, p. 602)

16-20. **SIAM Annual Meeting**, Chicago, IL. (Nov. 1988, p. 1389)

16-20. **Symposium Fraisse**, Marseille, France. (Jan. 1990, p. 58)

16-20. **NSF-CBMS Regional Conference "The Polynomial Identities and Invariants of $n \times m$ Matrices"**, DePaul Univ., Chicago, IL. (Mar. 1990, p. 330)

16-21. **Design and Analysis of Scientific Experiments**, Cambridge, MA. (Mar. 1990, p. 330)

16-27. **Regional Institute in Dynamical Systems**, Boston Univ., Boston, MA. (Mar. 1990, p. 330)

16-August 3. **Conference on "Enriching Discrete Mathematics Courses with Recent Developments"**, Univ. of Wyoming, Laramie, WY. (Apr. 1990, p. 495)

22-28. **Konvexgeometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

23-27. **CADE 10 - Tenth International Conference on Automated Deduction**, West Germany. (Feb. 1990, p. 223)

23-28. **Fourth International Congress on Computational and Applied Mathematics**, Leuven, Belgium. (Jan. 1990, p. 58)

23-August 4. **Third Workshop on Stochastic Analysis**, Silivri, Istanbul-Turkey. (Feb. 1990, p. 223)

*24-August 2. **A Summer School and Conference on Proof Theory**, University of Leeds, Leeds, UK.

PURPOSE: This meeting is intended to foster closer collaborative links between mathematical logicians and computer scientists interested in the general proof theory area.

CONFERENCE TOPICS: Basic proof theory and cut elimination, proof theory and ordinal analysis, linear logic, type theory and calculus of constructions, proofs and programs.

INVITED SPEAKERS: W. Buchholz (Munich), S. Feferman (Stanford), J.-Y. Girard (Paris), D. R. Harper (Carnegie-Mellon), D. Howe (Cornell), G.E. Mints (Tallinn), W. Pohlers (Munster), H. Schwichtenberg (Munich), L. Wallen (Oxford).

INFORMATION: "Proof Theory 1990," S. Wainer, School of Mathematics, Leeds University, Leeds LS2 9JT, UK.

26-29. **International Conference on New Trends in Geometric Function Theory**

and Applications, University of Madras, Madras, India. (Sep. 1989, p. 918)

29-August 4. **Mechanik Und Algebraische Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

30-August 4. **The Fourth International Conference on Fibonacci Numbers and their Applications**, Wake Forest University, Winston Salem, NC. (Nov. 1989, p. 1252)

31-August 2. **Dynamics of Numerics and the Numerics of Dynamics**, Bristol, England. (Nov. 1989, p. 1252)

August 1990

August 1990-May 1991. **Special Year in Real Algebraic Geometry and Quadratic Forms**, University of California, Berkeley, CA.

PROGRAM: A special year devoted to the study of quadratic forms and real algebraic geometry will bring foreign and American researchers to the campus for visits of varying length for the 1990-1991 academic year. The plan is: to have a couple of advanced seminars as well as a more general seminar at the graduate level per week; to promote interaction among workers in these areas, foster interaction between visitors and workers in other areas, and to stimulate American research in these fields. The Special Year's activities should result in a technical proceedings publication and a survey of the current state of real algebraic geometry and quadratic forms written by some of the visiting experts.

SPONSORS: U.C. Berkeley, N.S.A., (funding applied for from NSF and other sources).

INVITED SPEAKERS: M. Knebusch, L. Broecker, W. Scharlau, J.-L. Colliot-Thelene, C. Andradas, R.S. Parimala, A. Wadsworth, T.Y. Lam, G. Stengle, R. Robson, D. Leep, C. Delzell.

INFORMATION: From the organizers: T.Y. Lam, Dept. of Mathematics, U.C. Berkeley, email: (lam@math.berkeley.edu) and R. Robson, Oregon State Univ., email: (robby@math.orst.edu).

1-5. **Topology Conference**, University of Georgia, Athens, GA.

INVITED SPEAKERS: C. Adams, L. Conlon, A. Edmonds, A. Hatcher, J.

Sha, M. Thistlethwaite, and others to be announced.

INFORMATION: W. Kazez or C. McCrory, Math. Dept., Univ. of Georgia, Athens, GA 30602; Bitnet: will@uga or cmccrory@uga.

2-3. **AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology, Neural Networks**, Vancouver, Canada. (Mar. 1990, p. 330)

5-9. **From Topology to Computation: Unity and Diversity in the Mathematical Sciences (in Honor of Professor Stephen Smale's 60th Birthday)**, Berkeley, CA. (Jan. 1990, p. 58)

5-11. **Mathematical Methods in Tomography**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

5-11. **International Conference on Approximation Theory**, Hungary. (Oct. 1989, p. 1097)

6-7. **AMS Short Course on Combinatorial Games**, Columbus, Ohio.

INFORMATION: M. Foulkes, AMS, P.O. Box 6248, Providence, RI 02940.

6-9. **1990 Joint Statistical Meetings**, Anaheim, CA. (Mar. 1988, p. 466)

6-10. **Singularities**, Honolulu, Hawaii. (Feb. 1990, p. 223)

8-11. **Joint Mathematics Meetings**, Ohio State University, Columbus, OH. (including the summer meetings of the AMS, AWM, MAA and PME). This is the 75th Anniversary of the MAA.

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

8-11. **The Fifth KIT Mathematics Workshop**, Korea Institute of Technology, Taejeon, Korea. (Mar. 1990, p. 330)

11-14. **Crypto '90**, University of California, Santa Barbara, CA. (Apr. 1990, p. 495)

12-13. **Workshop on Using Technology to Enhance the Teaching and Learning of Calculus and Precalculus Mathematics**, The Ohio State Univ., Columbus, OH. (Mar. 1990, p. 330)

12-18. **Algebraische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

12-18. **Pre-Congress Topology Conference**, University of Hawaii, Honolulu, HI. (Feb. 1990, p. 223)

13-16. **Alaska Conference, Quo Vadis**,

Graph Theory?, University of Alaska, Fairbanks, AK. (Oct. 1989, p. 1097)

13-17. **Fifth International Conference on Hadronic Mechanics and Nonpotential Interactions**, University of Northern Iowa, Cedar Falls, Iowa. (Jul./Aug. 1989, p. 768)

13-17. **Eleventh IFAC World Congress**, Tallin, USSR. (Sep. 1989, p. 918)

13-17. **Algebraic Geometry and Analytic Geometry**, Tokyo, Japan. (Sep. 1989, p. 919)

13-17. **1990 International Conference on Parallel Processing**, Pennsylvania State University, University Park, PA. (Dec. 1989, p. 1438)

13-17. **NSF/CBMS Conference on Random Number Generation and Quasi-Monte Carlo Methods**, Univ. of Alaska, Fairbanks, AK. (Mar. 1990, p. 331)

13-18. **Institute of Mathematical Statistics Fifty-third Annual Meeting (jointly with the Second World Congress of the Bernoulli Society)**, Uppsala, Sweden. (Sep. 1989, p. 919)

13-18. **Tsukuba International Conference on Representations of Algebras and Related Topics**, University of Tsukuba, Japan. (Nov. 1989, p. 1253)

14-18. **The Asian Mathematical Conference 1990**, Hong Kong, China. (Sep. 1989, p. 919)

14-18. **Harmonic Analysis, Sendai 1990**, Tohoku University, Sendai, Japan. (Feb. 1990, p. 223)

14-18. **Zeta Functions in Geometry**, Tokyo Institute of Technology, Tokyo, Japan. (Feb. 1990, p. 223)

* 15-19. **International Conference on Knot Theory & Related Topics**, Naniwa-Kaikan Hotel, Osaka City, Japan. (Please note change in location from Apr. 1989, p. 497)

15-19. **International Conference on Commutative Algebra and Combinatorics**, Nagoya University, Nagoya, Japan. (Feb. 1990, p. 224)

15-20. **Conference on Gaussian Random Fields (The Third Nagoya Lévy Seminar)**, Nagoya University, Nagoya, Japan. (Nov. 1989, p. 1253)

16-18. **SIGAL International Symposium on Algorithms**, Tokyo, Japan. (Oct. 1989, p. 1097)

16-19. **Current Topics in Operator Algebras**, Nara Ken-New Public Hall, Nara, Japan. (Feb. 1990, p. 224)

18-22. **The Second International Confer-**

ence on Graph Theory, Kanagawa, Japan. (Feb. 1990, p. 224)

19-20. Inverse Problems in Engineering Sciences, Osaka Institute of Technology, Osaka, Japan. (Feb. 1990, p. 224)

19-25. Mathematische Methoden Des VLSI-Entwurfs Und Des Distributed Computings, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

20-24. Second International Joint Conference of the ISSAC-90 and the AAECC-8, Nihon University, Tokyo, Japan. (Feb. 1990, p. 224)

20-24. International Conference on Combinatorics (ICC '90), Hefei, Anhui, China. (Apr. 1990, p. 495)

20-25. Fifth Conference on Numerical Methods, Miskolc, Hungary. (Jan. 1990, p. 59)

21-29. The International Congress of Mathematicians 1990, Kyoto, Japan. (Nov. 1988, p. 1389)

23-September 1. Twenty-eighth International Symposium on Functional Equations, Graz-Mariatrost, Austria. (Dec. 1989, p. 1438)

26-September 1. Komplexe Analysis, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

27-31. Eleventh Prague Conference on Information Theory, Statistical Decision Functions and Random Processes, Praha, Czechoslovakia. (Jan. 1990, p. 59)

28-30. IMACS European Simulation Meeting on Problem Solving by Simulation, Esztergom, Hungary. (Mar. 1989, p. 316)

28-31. Operations Research 1990, International Conference Operations Research, Vienna, Austria. (Jul./Aug. 1989, p. 768)

29-31. International Colloquium on Words, Languages, and Combinatorics, Kyoto Sangyo University, Kyoto, Japan. (Feb. 1990, p. 224)

30-September 1. International Symposium on the Semigroup Theory and its Related Fields, Ritsumeikan University, Kyoto, Japan. (Feb. 1990, p. 224)

30-September 2. International Symposium on Functional Differential Equations and Related Topics, Kyoto Shigaku Kaikan (YOUANDI), Kyoto, Japan. (Feb. 1990, p. 224)

30-September 4. International Conference on Potential Theory, Nagoya, Japan. (May/Jun. 1989, p. 602)

30-September 4. International Sym-

posium on Computational Mathematics, Matsuyama, Japan. (Feb. 1990, p. 224)

31-September 1. Tokyo History of Mathematics Symposium 1990, University of Tokyo, Tokyo, Japan. (Feb. 1990, p. 224)

31-September 2. Conference on Representation Theories of Lie Groups and Lie Algebras, Lake-Kawaguchi, Yamanashi, Japan. (Feb. 1990, p. 224)

31-September 4. International Symposium on Functional Analysis and Related Topics, Sapporo, Japan. (Feb. 1990, p. 225)

31-September 4. General Topology and Geometric Topology Symposium, University of Tsukuba, Japan. (Feb. 1990, p. 225)

September 1990

September/October 1990. IMACS-GAMM Conference on Computer Arithmetic, Scientific Computation and Mathematical Modelling, Bulgaria. (Sep. 1989, p. 919)

IMACS Symposium on Modelling and Simulation of Electrical Machines, ENSEM - Nancy, France. (May/Jun. 1989, p. 602)

2-7. Twelfth International Conference on Nonlinear Oscillations, Cracow, Poland. (Sep. 1989, p. 919)

2-7. International Conference on Integral Equations and Boundary Value Problems, Yantai University, Shandong, People's Republic of China. (Nov. 1989, p. 1253)

2-8. Topologie, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

3-6. Fourth Asian Logic Conference, Tokyo, Japan. (Mar. 1989, p. 316)

3-7. IMACS Symposium on Intelligent Models in Systems Simulation, Brussels, Belgium. (Mar. 1989, p. 316)

3-7. Representation des Groupes et Analyse Complexe, Marseille, France. (Jul./Aug. 1989, p. 768)

3-7. International Conference on Dynamical Systems and Related Topics, Nagoya University, Nagoya, Japan. (Feb. 1990, p. 225)

3-8. Physical Interpretations of Relativity Theory, Imperial College, London, England. (Mar. 1990, p. 331)

8-12. Neuronet-90: IMACS International Symposium on Neural Nets and Neural Computers, Prague, Czechoslovakia.

(Please note change from May/Jun. 1989, p. 602)

9-15. Surgery and L-Theory, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 9-22. Computer Algorithms for Solving Linear Algebraic Equations: The State of the Art, Il Ciocco, Castelveccchio Pascoli, Tuscany, Italy.

PURPOSE: To review the state of art of algorithms for solving linear systems, particularly of large dimension. Special attention is paid to algorithms for parallel computers.

INVITED SPEAKERS: C. Broyden (Essex), V. Pan (NY), O. Axelsson (Nijmegen), A. Björk (Linköping), E. Spedicato (Bergamo), J. Abaffy (Budapest), W. Hackbusch (Kiel), H. Yserentant (Dortmund), G. Meurant (Villeneuve), L. Dixon (Hatfield), M. Cosnard (Lyon), Y. Robert (Lyon), I. Duff (Harwell), I. Galligani (Bologna), G. Radicati (Roma).

INFORMATION: Course Director, E. Spedicato, Dept. of Math., Università, via Salvechio 19, 24100 Bergamo, Italy; Tel: 035/277514; Fax: 035/243054.

10-12. Second International Workshop on Advances in Robot Kinematics, Linz, Austria. (Mar. 1990, p. 332)

10-14. Mathematiker-Kongress, Dresden, German Democratic Republic. (Jul./Aug. 1989, p. 769)

10-14. Greco Calcul Formel, Marseille, France. (Jan. 1990, p. 60)

10-14. Real Analysis and Measure Theory, Capri, Italy. (Mar. 1990, p. 332)

10-October 5. School on Qualitative Aspects and Applications of Nonlinear Evolution Equations, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 602)

* 13-18. The Marshall Hall 80th Birthday Conference on Coding Theory, Design Theory and Group Theory, University of Vermont, Burlington, VT.

PROGRAM: This conference will honor Marshall Hall's lifelong contributions to coding theory, design theory, and group theory by bringing together top researchers in these areas with the purpose of discussing the latest advances and promoting interdisciplinary research.

ORGANIZING COMMITTEE: K. Arasu (Wright State), M. Ashbacher (Caltech), J. Dinitz (Vermont), R. Foote (Vermont), D. Jungnickel (Giessen), S. Vanstone (Waterloo).

INVITED SPEAKERS: J. Alperin (Chicago), P. Cameron (London), J. Dillon (Dept. of Defense), D. Gorenstein (Rutgers), G. Higman (Oxford), D. Knuth (Stanford), R. McEliece (Caltech), D. Ray-Chaudhuri (Ohio State), L. Teirlinck (Auburn), J. Thompson (Cambridge), A. Bruen (Western Ontario), J. Conway (Princeton), W. Feit (Yale), J. Hall (Michigan State), W. Kantor (Oregon), J. van Lint (Eindhoven), R. Mullin (Waterloo), G. Seitz (Oregon), J. Tits (College de France), R. Wilson (Caltech).

INFORMATION: Marshall Hall Conference, Dept. of Math. and Stat., Univ. of Vermont, 16 Colchester Ave., Burlington, VT 05405.

*16-22. **Ankündigung der Jahrestagung 1990**, Universität Bremen, Bremen, W. Germany.

CONFERENCE TOPICS: Algebra, zahlen-theorie, diskrete mathematik, logik und theoretische informatik, geometrie, topologie, funktionalanalysis, komplexe analysis, differentialgleichungen, angewandte mathematik, numerik, stochastik.

INVITED SPEAKERS: F. Hirzebruch, Bonn; K. Kirchgässner, Stuttgart; J. Lindenstrauss, Jerusalem; B. Trager, Yorktown Heights; W. Hackbusch, Kiel; H. Bender, Kiel; W. Schmid, Cambridge, USA; L. Lovász, Budapest; U. Abresch, Münster; G.-M. Greuel, Kaiserslautern; R. Pyke, Seattle; R. Jensen, Oxford; M.-F. Vignéras, Paris; W. Schmidt, Boulder; M. Kreck, Mainz; R.E. Tarjan, Princeton; E. Brieskorn, Bonn.

INFORMATION: Organisations-Komitee, der DMV-Tagung 1990, FB Mathematik u. Informatik, Universität Bremen, D-2800 Bremen 33.

16-22. **Risikotheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

17-21. **Atelier International de Theorie des Ensembles**, Marseille, France. (Jan. 1990, p. 60)

17-22. **DMV-Jahrestagung 1990**, Bremen, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

*19-21. **Third IMACS International Conference on Modelling and Simulation of Electrical Machines and Static Converters**, ENSEM - Nancy, France.

PURPOSE: The conference aims at establishing a high-standard international meeting point in order to exchange informations and new results of research in modelling and simulation in the various fields of electrical engineering.

INFORMATION: Secretariat IMACS-TC1 '90, A. Rezzoug, G.R.E.E.N.-E.N.S.E.M., 2, rue de la Citadelle, B.P. 850, 54011 Nancy Cedex, France; Telex: ENSEM 961316 F, Tel:83 32 39 01; Telefax: Club F I P 33/83 32 42 50.

21-27. **International Functional Analysis Meeting on the Occasion of the Sixtieth Birthday of Professor M. Valdivia**, Peñíscola (Castellón), Spain. (Apr. 1990, p. 497)

23-29. **Random Graphs and Combinatorial Structures**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

24-28. **Structure Galoisienne Arithmetique**, Marseille, France. (Jan. 1990, p. 60)

24-28. **IMACS-GAMM International Symposium on Computer Arithmetic, Scientific Computation and Mathematical Modelling - SCAN 1990**, Albena (near Varna), Bulgaria. (Feb. 1990, p. 225)

*24-28. **International Symposium on Structures in Mathematical Theories**, San Sebastian, Espagna.

INFORMATION: J. Echeverria or A. Ibarra, Dept. de Logica y Filosofia de la Ciencia, Universidad del Pais Vasco, Euscal Herriko Unibertsitatea, Apartado 1249, E-20080 San Sebastian.

24-29. **Mathematical Modelling of Industrial Processes**, Tecnopolis, Bari. (Feb. 1990, p. 225)

24-30. **Ibero-American Conference**, Seville, Spain. (Apr. 1990, p. 497)

25-29. **International Symposium on Structures in Mathematical Theories**, San Sebastián, Spain. (Apr. 1990, p. 497)

*27-29. **Topology and Geometry of Manifolds**, Bologna, Italy.

INVITED SPEAKERS: A. Costa (UNED, Madrid), P.B. Gilkey (Univ. of Oregon), J. Jost (Univ. of Paris), J. L. Loebl (Univ. of Madrid), S. Murakami (Univ. of Tokyo), R. P. Stanley (Univ. of Michigan), J. van Lint (Univ. of Amsterdam), J. Wilson (Univ. of Cambridge), T. Hangan (Univ. de l'Haute Alsace), D. Repovš (Univ. Ljubljana), A. Sanini (Polit. di Torino), G. Tomassini (S.N.S. Pisa).

INFORMATION: M. Ferri, University of Bologna, Dipartimento di Matematica, Piazza di Porta S. Donato, 5-40127 Bologna (Italia); Tel: (051)354401; Telefax: (051) 354490; email: bitnet-ferri@dm.unibo.it.

28-29. **Linear Algebra and its Applications**, Miami University, Oxford, OH. (Apr. 1990, p. 497)

30-October 6. **Diophantische Approximationen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

October 1990

1-5. **Organisations et Theorie des Jeux**, Marseille, France. (Jan. 1990, p. 60)

1-5. **Third Joint Europe/U.S. Short Course in Hypersonics**, RWTH Aachen Univ. of Technology, Federal Republic of Germany. (Mar. 1990, p. 332)

5-6. **Math-History Conference**, LaCrosse, WI. (Jan. 1990, p. 60)

5-7. **Workshop on Partial Differential Equations**, Cornell Univ., Ithaca, NY. (Mar. 1990, p. 332)

7-13. **Arbeitsgemeinschaft Mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

8-12. **Congres Franco-Sovietique de Programmation Mathematique**, Marseille, France. (Jan. 1990, p. 60)

14-20. **Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

15-19. **Modeles pour L'Analyse des Donnees Multidimensionnelles**, Marseille, France. (Jan. 1990, p. 60)

15-19. **Tercer Congreso Nacional de Matematicas**, San José, Costa Rica. (Feb. 1990, p. 225)

*18-21. **Sixteenth Annual Convention of the American Mathematical Association of Two-Year Colleges**, Dallas, TX.

KEYNOTE SPEAKER: James Voytuk, Director of MS 2000 Project.

INFORMATION: E.W. Robinson, Cedar Valley College DCCCD, 3030 N. Dallas Ave., Lancaster, TX 75134-4997; or T. Thompson, Brookhaven College DCCCD, 3939 Valley View Lane, Farmers Branch, TX 75244-4997.

19-20. **Nineteenth Midwest Conference on Differential and Integral Equations**, Univ. of Missouri-Rolla, Rolla, MO. (Apr. 1990, p. 498)

* 19-20. **Twelfth Midwest Probability Colloquium**, Northwestern University, Evanston, IL.

INVITED SPEAKERS: M. Talagrand, B. Davis, G. Lawler.

INFORMATION: M. Pinsky, Dept. of Mathematics, Northwestern University, Evanston, IL 60208; email: m.pinsky@math.nwu.edu.

20-21. **Eastern Section**, University of Massachusetts at Amherst, Amherst, MA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

21-27. **Mathematische Methoden In Der Robotik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

21-27. **Arithmetik der Körper**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

* 21-27. **International Functional Analysis Meeting on the Occasion of the Sixtieth Birthday of Professor M. Valdivia**, Peñíscola, Spain. (Please note changes from Oct. 1989, p. 1098)

SPONSORS: Univ. of Valencia and Polytechnical Univ. of Valencia.

CONFERENCE TOPICS: Locally convex spaces, Fréchet spaces, Banach space theory, function spaces, holomorphy, topological tensor products and operator ideals.

INVITED SPEAKERS: Altomare, Ansemil, Aron, Bessaga, Bombal, Cobos, A. Defant, S. Dierolf, Diestel, Dineen, Florencio, Floret, Godefroy, Isidro, Jarchow, Heinz, König, Llavona, Larsen, Meise, Moscatelli, Mujica, Nachbin, Orihuela, Pelczyński, Pietsch, Pisier, Schachermayer, Schmets, Taskinen, Terzioglu, D. Vogt.

22-25. **Fifth Jerusalem Conference on Information Technology (JCIT-5)**, Jerusalem, Israel. (Jan. 1990, p. 60)

26-27. **Statistical Mechanics at the 45th Parallel: Fourth Annual Meeting**, Université de Montréal, Canada. (Feb. 1990, p. 226)

* 26-28. **Twenty-first U.S.L. Mathematics Conference (Algebra)**, University of Southwestern Louisiana, Lafayette, LA.

INFORMATION: L. Roeling, Dept. of Mathematics, University of Southwestern Louisiana, Lafayette, LA 70504.

28-November 3. **Mathematical Economics**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

29-November 2. **Trieste Conference on Integrable Systems**, Trieste, Italy. (Jan. 1990, p. 61)

29-November 2. **Algorithmes Paralleles et Architectures Nouvelles**, Marseille, France. (Jan. 1990, p. 61)

29-November 2. **The International Conference "D-Modules and Microlocal Geometry"**, Lisbon, Portugal. (Mar. 1990, p. 333)

29-November 16. **Workshop on Mathematical Ecology**, Trieste, Italy. (Jan. 1990, p. 61)

31-November 3. **Latinamerican Seminar on Applications of Mathematics and Computer Science to Biology**, La Habana, Cuba. (Feb. 1990, p. 226)

November 1990

2-3. **Central Section Meeting of the AMS**, University of North Texas, Denton, TX.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

4-10. **Wahrscheinlichkeitsmaße auf Gruppen**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

5-7. **Second SIAM Conference on Linear Algebra in Signals, Systems & Controls**, San Francisco, CA. (Sep. 1989, p. 920)

6-7. **1990 ACM Conference on Critical Issues**, Arlington, VA. (Apr. 1990, p. 498)

9-11. **Third Annual Conference on Technology in Collegiate Mathematics**, The Ohio State Univ., Columbus, OH. (Mar. 1990, p. 333)

10. **Differential Geometry Day**, Eastern Illinois University, Charleston, IL. (Apr. 1990, p. 498)

10-11. **Far Western Section**, University of California, Irvine, CA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

12-16. **Supercomputing '90**, New York, NY. (Sep. 1989, p. 920)

12-16. **Workshop on Representations**

of **Reductive Groups over Finite Fields**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

* 16-17. **Tenth Annual Southeastern Atlantic Regional Conference on Differential Equations**, Virginia Polytechnic Institute and State University, Blacksburg, VA.

INVITED SPEAKERS: R. Beals, Yale; G. Sell, Minnesota; J. Ranch, Michigan. INFORMATION: SEARCD, Dept. of Mathematics, Virginia Polytechnic Institute and State Univ., Blacksburg, VA 24061-0123; 703-231-6575; Bitnet: searcd@vtmath; internet: searcd@vtmath.math.vt.edu.

18-24. **Komplexitätstheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 19-22. **Huygens' Principle 1690-1990, Theory and Applications**, Scheveningen, The Hague, The Netherlands.

PURPOSE: To present modern developments in mathematical methods in the theory of wave propagation; physical aspects of scattering and diffraction of waves; computational modelling; applications.

INFORMATION: Congress Bureau, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands.

* 25-28. **Mathematics and its Applications**, University of Bahrain, State of Bahrain.

CONFERENCE TOPICS: Numerical analysis, applied analysis, differential equations, applied statistics.

INVITED SPEAKERS: I. Babuska, USA; B.W. Conolly, U.K.; W.D. Evans, U.K.; W.N. Everitt, U.K.; J.-L. Lions, France; L. Markus, USA; J. Mawhin, Belgium; M. Mori, Japan; J. Noye, Australia; C.R. Rao, U.K.; A.B. Tayler, U.K.; E.H. Twizell, U.K.; J.R. Whiteman, U.K.; A.Y. Al-Hawaj, Bahrain; M.S.P. Eastham, Bahrain. CALL FOR PAPERS: Abstracts for contributed papers should be received by September 15, 1990.

INFORMATION: Conference Secretary, Mathematics Department, University of Bahrain, P.O. Box 32038, Isa Town, State of Bahrain.

25-December 1. **Stochastische Approximation Und Optimierungsprobleme In Der Statistik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

25-December 1. **Lineare Modelle und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

December 1990

2-8. **Multigrid Methods**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

3-5. **First International Symposium on Uncertainty and Analysis: Fuzzy Reasoning, Probabilistic Methods and Risk Management**, College Park, Maryland. (Oct. 1989, p. 1098)

3-7. **Sixteenth Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, Palmerston North, New Zealand. (Feb. 1990, p. 226)

3-7. **SINO-JAPANESE Joint Seminar on Nonlinear PDEs with Emphasis on Reaction-Diffusion Aspects.**, Taipei, Taiwan. (Jan. 1990, p. 61)

3-7. **Workshop on General Group Representation Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

9-15. **Allgemeine Ungleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

*11-12. **Integral Valued Polynomials Encounter**, CIRM, Marseille, France.

CONFERENCE TOPICS: Additive structure (well-ordered bases and Galois group), spectrum and Krull dimension (special notice to the non-noetherian case), polynomials in several indeterminates, integral valued derivatives and finitely divided differences, skolem and nullstellensatz properties, integral-valued rational fractions, integral-valued functions on a subset, Picard group.

INVITED SPEAKERS: R. Gilmer (Florida), D. McQuillan (Ireland), J.-L. Chabert (France), P.-J. Cahen (France), Y. Haouat (Tunisia).

INFORMATION: P.-J. Cahen, Case 322, Faculté des Sciences et Techniques de Saint-Jérôme, 13397 Marseille Cedex 13.

*11-13. **Third Joint IFSA-EC and EURO-WG Workshop on Fuzzy Sets**, Visegrád, Hungary.

PURPOSE: To present and discuss recent developments in all aspects of fuzzy sets and systems with an emphasis on the work done in Europe.

ORGANIZING COMMITTEE: M. Kovács, R. Fullér, J.C. Fodor, L.T. Kóczy, J. Sándor.

CONFERENCE TOPICS: Mathematical foundations of fuzzy sets and possibility theory, fuzzy mathematical structures, fuzzy logic and approximate reasoning, fuzzy sets and possibility theory in knowledge engineering and fuzzy expert systems, neural networks, applications.

INFORMATION: M. Kovács, Computer Center of L. Eötvös University, H-1502, Budapest 112, P.O. Box 157, Hungary; Tel: +(36)-1-1869066/1844, Fax: +(36)-1-1811976, telex 224185 eszkb h.

15-19. **Curves and Surfaces: An Algorithmic Viewpoint**, Kent State Univ., Kent, OH. (Apr. 1990, p. 499)

16-22. **Mathematische Logik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

17-21. **Non-linear Dispersive Wave Systems**, Univ. of Central Florida, Orlando, FL. (Apr. 1990, p. 499)

25-January 1. **Lineare Modelle Und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

Spring 1991. **IMACS International Symposium on Iterative Methods in Linear Algebra**, Brussels Free Univ., Brussels, Belgium. (Mar. 1990, p. 334)

January 1991

6-12. **Automorphe Formen und Anwendungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

7-10. **Sixth Caribbean Conference in Combinatorics and Computing**, University of the West Indies, St. Augustine, Trinidad. (Jan. 1990, p. 61)

13-19. **Combinatorial Optimization**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

14-15. **AMS Short Course on "Probabilistic Combinatorics and its Applications"**, San Francisco, CA.

INFORMATION: D. Plante, AMS, P.O. Box 6248, Providence, RI 02940.

16-19. **Joint Mathematics Meetings**, San Francisco, CA. (including the annual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

20-26. **Spektraltheorie Singulärer Gewöhnlicher Differentialoperatoren**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

27-February 2. **Harmonische Analyse und Darstellungstheorie Topologischer Gruppen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

February 1991

3-9. **Konstruktive Methoden in der Komplexen Analysis**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

10-16. **Endlichdimensionale Lie-Algebren**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

10-16. **Affine Differentialgeometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

24-March 2. **Medical Statistics: Statistical Models for Longitudinal Data**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

25-March 1. **IEEE Computer Society COMPCON Spring '91**, San Francisco, CA. (Jan. 1990, p. 62)

March 1991

3-9. **Partielle Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

* 5-7. **Association for Computing Machinery 1991 Computer Science Conference**, San Antonio Convention Center, San Antonio, TX.

PROGRAM: The theme is "Preparing for the 21st Century". This year's program will emphasize the coupling among the stages in the technology transfer pipeline by featuring three tracks which are: future technologies, research results, and prototype systems and case studies.

CONFERENCE TOPICS: Architectures,

systems, theory of computation, software, human interfaces, applications, artificial intelligence.

CALL FOR PAPERS: Formal papers and case studies are solicited from all domains of computer science research, novel applications of basic research or CS technology forecasting. Papers should not exceed 20 double-spaced pages (5,000 words). Five copies of completed papers in form suitable for review must be received by August 1, 1990. Research abstracts and short reports are limited to a maximum of 500 words and will be presented in poster session format. Abstracts in camera-ready form must be received by November 1, 1990.

INFORMATION: Papers: R. Brice, MCC Corporation, 3500 West Balcones Center Dr., Austin, TX 78759; 512-338-3429; email: rsb@mcc.com. Posters: G. Bailes, Dept. of Comp. and Information Sciences, East Tennessee State Univ., Box 23830A, Johnson City, TN 37614-0002; 615-929-5332; email: I01baile@etsu.

*** 7-8. Twenty-second ACM SIGCSE Technical Symposium on Education in the Computing Sciences, San Antonio, TX.**

PROGRAM: The theme of the 1991 Symposium is "Education, Research, Industry: Keep the Information Flowing".

CALL FOR PAPERS: Papers, case studies, tutorials, workshops, and panel sessions on topics relating to this theme or any other issues of concern to computing science educators are solicited. Four copies (maximum of 12 double-spaced pages) of completed papers, case studies, and proposals for panels, workshops, or tutorials should be received by September 1, 1990.

INFORMATION: N. Dale, Chairperson, Department of Computer Sciences, University of Texas at Austin, Austin, TX 78712; 512-471-9539; email: ndale@cs.utexas.edu.

*** 7-10. International Conference on Differential Equations, Cadi Ayyad University, Marrakech, Morocco.**

INFORMATION: A. El Koutri, Université Cadi Ayyad, Dept. of Math., Boulevard de Safi, B.P. S 15, Marrakech.

10-16. **Mathematische Stochastik**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

*** 11-15. NSF-CBMS Regional Research Conference on Nonlinear Dispersive Wave Systems**, University of Central Florida, Orlando, FL.

PRINCIPLE SPEAKER: T. Brooke Benjamin, University of Oxford, England.
INFORMATION: L. Debnath, Dept. of Mathematics, Univ. of Central Florida, Orlando, FL 32816; 407-275-2478; Fax: 407-281-5156.

*** 13-15. IMACS Workshop on Decision Support Systems and Qualitative Reasoning**, LAAS-Toulouse, France.

CALL FOR PAPERS: Deadline for receipt of abstracts: September 30, 1990.
INFORMATION: M.-T. Ippolito, DSSQR-IMACS Workshop, L.A.A.S./C.N.R.S., 7, Avenue du Colonel Roche, 31077 Toulouse Cedex, France; Tel: (33) 61-33-62-74, Telefax: (33) 61-55-35-77, Telex: LAASTSE 520930F; email: louis@laas.laas.fr.

16-17. **Central Section**, Indiana University, South Bend, IN.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

17-23. **Elementare und Analytische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

*** 17-24. Sixth International Conference on Geometry**, University of Haifa, Israel.

CONFERENCE TOPICS: Foundations of geometry, geometric algebra, combinatorial geometry, convexity and convex polytopes.

INFORMATION: R. Artzy or J. Zaks, Dept. of Mathematics, University of Haifa, Israel.

21-23. **Sixth S.E.A. Meeting, South-eastern Approximation Theorists Annual Meeting**, Memphis State Univ., Memphis, TN. (Mar. 1990, p. 334)

22-23. **Southeastern Section**, University of South Florida, Tampa, FL.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

22-24. **Fifth SIAM Conference on Parallel Processing for Scientific Computing**,

Houston, TX. (Mar. 1990, p. 334)
24-30. **Gewöhnliche Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)
31-April 6. **Arbeitsgemeinschaft mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

April 1991

*** 2-4. IMACS International Symposium on Iterative Methods in Linear Algebra**, Brussels Free Universities, Belgium.

PROGRAM: Recent advances in the analysis and implementation of iterative methods for solving large sparse systems of linear equations and for determining eigenvalues, eigenvectors and singular values of large space matrices.

CONFERENCE TOPICS: Matrix analysis (convergence, conditioning), implementation (on vector and parallel computers), software developments (sparse linear systems, sparse eigenproblems), applications (partial differential equations, systems theory).
INVITED SPEAKERS: O. Axelsson, M. Deville, E. Mund, R.S. Varga, and E.L. Wachspress.

CALL FOR PAPERS: Deadline for submission of abstracts: September 15, 1990.

INFORMATION: R. Beauwens, IMACS International Symposium, Université Libre de Bruxelles, C.P.165. 50, Av. F.D. Roosevelt, 1050 Brussels, Belgium; email: beauwens@bbrnsf11.bitnet.

7-13. **Algebraische Gruppen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

8-12. **Seventh International Conference on Data Engineering**, Kobe, Japan. (Apr. 1990, p. 500)

*** 8-12. NASECODE VII, The Seventh International Conference on the Numerical Analysis of Semiconductor Devices and Integrated Circuits**, Copper Mountain, Colorado.

CONFERENCE TOPICS: Process modelling, device modelling, circuit modelling, physical aspects, mathematical techniques, computational techniques, hot carriers, hydrodynamic models, avalanche and Monte Carlo techniques.

CALL FOR PAPERS: Potential contributors should submit an abstract (one page, 500 words maximum) which must clearly state the purpose of the work, the specific original results obtained and their significance. Abstract deadline: Nov. 15, 1990.

INFORMATION: J. Miller, NASECODE VII Conference, 26 Temple Lane, Dublin 2, Ireland; Telefax: +353-1-679-2469; Telex: 93782 TCD EI (attn: J. Miller); email: jmillier@vax1.tcd.ie; tel: +353-1-679-7655.

14-20. **Brauer Groups and Representation Theory of Finite Groups**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

28-May 4. **Deductive Systems**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

May 1991

May/June 1991. **IMACS Workshop on Decision Support Systems and Qualitative Reasoning**, Toulouse, France. (Mar. 1990, p. 334)

7-10. **IMACS Symposium on Modelling and Simulation of Control Systems**, Casablanca, Morocco. (Mar. 1990, p. 334)

12-18. **Nichtlineare Evolutionsgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

13-17. **Conference in Harmonic Analysis in Honor of E.M. Stein**, Princeton University, Princeton, NJ. (Mar. 1990, p. 334)

19-25. **Differentialgeometrie im Grossen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

22-24. **Second International Conference on Algebraic Methodology and Software Technology**, (AMAST), Iowa City, IA. (Apr. 1990, p. 501)

26-June 1. **Optimalsteuerung und Variationsrechnung-Optimal Control**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

June 1991

June 1991. **Third IMACS International Symposium on Computational Acoustics**, Harvard Univ., Cambridge, MA. (Mar. 1990, p. 334)

2-8. **Diskrete Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

3-7. **1991 Annual Meeting of the Statistical Society of Canada**, Toronto, Ontario, Canada. (Mar. 1990, p. 334)

9-15. **Singuläre Störungsrechnung**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

10-14. **Bernoulli Society Twentieth Conference on Stochastic Processes and their Applications**, Nahariya, Israel. (Nov. 1989, p. 1254)

17-21. **1991 International Symposium on the Mathematical Theory of Networks and Systems (MTNS-91)**, International Conference Center Kobe, Kobe, Japan. (Nov. 1989, p. 1254)

* 17-21. **European Conference on Elliptic and Parabolic Problems**, Pont à Mousson, France.

CONFERENCE TOPICS: General theory of elliptic and parabolic problems, applications, free boundary problems, fluid mechanics, calculus of variations, homogenization, modeling and numerical analysis.

INVITED SPEAKERS: J. Ball (Heriot-Watt), A. Bensoussan (INRIA), H. Brezis (Paris 6), F. Brezzi (Pavia), J.I. Diaz (Madrid), L.C. Evans (Berkeley), L.E. Fraenkel (Bath), A. Friedman (Minneapolis), M. Giaquinta (Florence), J.K. Hale (Georgia Inst. Tech.), R. Hardt (Rice), P. Hess (Zurich), S. Hildebrandt (Bonn), K.H. Hoffmann (Augsburg), G. Iooss (Nice), R. Kersner (Budapest), D. Kinderlehrer (Minneapolis), G.H. Knightly (Amherst), R.V. Kohn (NY), H.A. Levine (Iowa State), P.L. Lions (Paris Dauphine), J. Ockendon (Oxford), J.F. Rodrigues (Lisbon), L. Simon (Stanford), G. Talenti (Florence), L. Tartar (Carnegie-Mellon).

CALL FOR PAPERS: Deadline for submitting abstracts is November 1, 1990.

INFORMATION: C. Bandle, Mathematisches Institut der Univ., Rheinsprung 21, CH-4051 Basel, (Switzerland), Tel: (61) 25 03 01; M. Chipot and J. Saint Jean Paulin, Univ. de Metz, Dept. de Math., Ile du Saulcy, 57 045 Metz-Cedex 01 (France); Tel: 87 30 58 40, 87 31 03 38; J. Bemelmans and M. Grüter, Univ. des Saarlandes, Fachbereich 9 Mathematik, D-6600 Saarbrücken (Federal Republic of Germany), Tel: (681) 302 3406 or (681) 302 2287.

30-July 6. **Elliptische Operatoren auf Singulären und Nichtkompakten Mannigfaltigkeiten**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

September 1991

* 25-27. **Ninth GAMM Conference on Numerical Methods in Fluid Mechanics**, Lausanne, Switzerland.

PURPOSE: The theme of the conference is the development and application of numerical methods in fluid mechanics.

INVITED SPEAKERS: M. Deville (Louvain-la-Neuve), B. Gampert (Essen), W. Kordulla (Göttingen), Y. Morchoisne (Chatillon), K. Morgan (London), R. Piva (Rome), W. Prosnak (Gdansk), A. Rizzi (Bromma), B. Roux (Marseille), D. Rues (Göttingen), I.L. Ryhming (Lausanne), W. Schönauer (Karlsruhe), U. Schumann (Oberpfaffenhofen), Y.I. Shokin (Krasnoyarsk), C. Weiland (München), P. Wesseling (Delft).

INFORMATION: I.L. Ryhming (Chairman), IMHEF/DME, EPFL, CH-1015 Lausanne, Switzerland; tel: 41 21 693 35 03; Fax: 41 21 693 36 46 or 693 25 25.

June 1992

* 15-19. **Twenty-first International Conference on Stochastic Processes and their Applications**, Toronto, Canada.

INFORMATION: G.L. O'Brien, Department of Mathematics, York University, 4700 Keele St., North York, Ontario, Canada M3J 1P3; 416-736-5250; Fax 416-736-5735; email: omega@vm1.yorku.ca.

New AMS Publications

ALMOST PERIODIC MEASURES

Loren N. Argabright and Jesús Gil de Lamadrid

(Memoirs of the AMS, Number 428)

In this book, the authors provide a thorough and organized presentation of a substantial portion of current research in abstract harmonic analysis carried out on three continents, in a field that has been characterized by multiple rediscoveries of results and concepts by authors unaware of the work of others. The book recasts the classical theory of H. Bohr of almost periodic functions in a form sufficiently abstract and general as to encompass not only Bohr's original theory, but also more recent manifestations of almost periodicity in the work of Wiener, Stepanov, Besicovitch, Eberlein, and Jacobs. A substantial portion of the book is devoted to the application of the general theory to the study of mixed norm (amalgam) space and to the study of the general Fourier transform introduced by the same authors in an earlier work (*Memoirs of the AMS*, Number 145). The present book builds on basic notions and systematically develops the concepts and results in a leisurely manner from the general to the concrete, with each step leading naturally to the next. In addition, it provides a simple, general framework for formulating and proving general results which easily lead to many major, loosely related results in the existing literature.

Requiring a solid grounding in the theory of locally compact abelian groups and abstract (or classical) Fourier analysis, this book will be of interest to advanced graduate students in abstract harmonic analysis and topological representation theory, as well as to researchers in Fourier analysis, almost periodicity, and ergodic theory.

Contents

Translation stable spaces of measures; Amenable measures and Bohr formulas; Almost periodic measures; Multipliers; The Bohr compactification and the Eberlein decomposition; Fourier-Bohr series; Further study of the Bohr mapping; Further development of the theory of the Fourier transform of unbounded measures; Almost periodicity of the generalized Fourier transform; Support and symmetry groups.

1980 *Mathematics Subject Classifications*: 43-XX, 43A05, 43A07, 43A25, 43A35, 43A60, 43A65
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POSITIVE DEFINITE UNIMODULAR LATTICES WITH TRIVIAL AUTOMORPHISM GROUPS

Etsuko Bannai

(Memoirs of the AMS, Number 429)

In this book, the author proves that there exists a lattice with trivial automorphism group in every genus of positive definite unimodular \mathbb{Z} -lattices of rank m (with $m \geq 43$ for the odd unimodular case and $m \geq 144$ for the even unimodular case). Siegel's mass formulas for lattices (for both orthogonal and hermitian cases) are used in the proof. In addition, the author shows that, for those positive definite unimodular \mathbb{Z} -lattices in the given genus and of rank m , the ratio of the mass of classes with nontrivial automorphisms to the mass of all classes approaches 0 very rapidly as m increases. The book is intended for researchers and advanced graduate students in the areas of number theory and quadratic forms.

Contents

Preliminaries; Quadratic lattices and their mass formulas; Hermitian lattices and their mass formulas; General theory; Lattices with non-trivial automorphisms whose minimal polynomials are reducible; Lattices with non-trivial automorphisms whose minimal polynomials are irreducible; Local densities; Local densities of hermitian lattices; List of quadratic lattices over 2-adic integers and their local densities; Estimations; The estimation of $\omega_{R(2)}/\omega(L)$; The estimation of $\omega_{R(q)}/\omega(L)$, $q \neq 2$; The estimation of $\omega_{IR(q)}/\omega(L)$; Proof of the theorems; Proof of the theorems.

1980 *Mathematics Subject Classification*: 10C
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70 pages (softcover), May 1990
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STABILITY IN MODULES FOR CLASSICAL LIE ALGEBRAS: A CONSTRUCTIVE APPROACH

G. M. Benkart, D. J. Britten, and F. W. Lemire

(Memoirs of the AMS, Number 430)

During the last century, mathematicians and physicists alike have studied extensively the finite dimensional irreducible representations of complex classical Lie algebras. These

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studies have led to numerous formulas for computing the dimensions, weights, weight multiplicities, and tensor products of the representations. The dependence of these quantities on the rank of the Lie algebra has been revealed in recent investigations using Schur functions and characters.

This book develops a constructive approach to the rank dependence, beginning from Hermann Weyl's realization of the module inside a certain M -fold tensor product of the natural representation. New proofs are derived for some of the more difficult aspects of Weyl's construction, especially those involving contraction maps. The explicit structural information about weights and maximal vectors obtained here show that the rank dependence and stability of the modules occur not just on a character level, but occur because the structure of the modules and their tensor products is basically the same in each case. For those having some familiarity with Lie algebras and their representations, the book provides sufficient background to make the monograph self-contained.

Contents

The tensor product realization; The dominant weights of $\otimes^M V(\omega_1, X_r)$; The dominant weights of $V(\lambda, X_r)$; Dimensions and polynomials; Stability of $g_r(\otimes^M V(\omega_1, X_r)) \otimes g_{r'}(\otimes^{M'} V(\omega_1, X_r))$; Stability of $V(\lambda, X_r) \otimes V(\lambda', X_r)$; Multiplicities of the dominant weights of $V(\lambda, X_r)$; Algorithms and examples.

1980 Mathematics Subject Classifications: 17B10, 05A17, 22E46
ISBN 0-8218-2492-9, LC 90-31825, ISSN 0065-9266

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PROBABILITY THEORY, FUNCTION THEORY, MECHANICS

Yu. V. Prokhorov, Editor

(Proceedings of the Steklov Institute, Volume 182)

This is a translation of the fifth and final volume in a special cycle of "Trudy of the Steklov Mathematical Institute of the Academy of Sciences," published in commemoration of the 50th anniversary of the Institute. The purpose of the special cycle of publications was to present surveys of work on certain important trends and problems pursued at the Institute. Because the choice of the form and character of the surveys were left up to the authors, the surveys do not necessarily form a comprehensive overview, but rather represent the authors' perspectives on the important developments.

The survey papers in this collection range over a variety of areas, including: probability theory and mathematical statistics, metric theory of functions, approximation of functions, descriptive set theory, spaces with an indefinite metric, group representations, mathematical problems of mechanics, and spaces of functions of several real variables and some of its applications.

Contents

E. F. Mishchenko, Introduction; A. N. Kolmogorov, Yu. V. Prokhorov, and A. N. Shiryayev, Probabilistic-statistical methods of detecting spontaneously occurring effects; V. M. Zolotarev, On real refinements of limit theorems in probability theory; Yu. A. Rozanov, On some aspects of prediction theory; V. V. Sazonov, Normal approximation

in finite-dimensional spaces and Hilbert spaces; O. V. Besov, L. D. Kudryavtsev, P. I. Lizorkin, and S. M. Nikol'skii, Investigations in the theory of spaces of differentiable functions of several variables; S. A. Telyakovskii, Research in the theory of approximation of functions at the Mathematical Institute of the Academy of Sciences; P. L. Ul'yanov, The metric theory of functions; V. N. Grishin and V. G. Kanovei, On work in descriptive set theory carried out at the Mathematical Institute of the Academy of Sciences; D. V. Anosov, On the work of L. S. Pontryagin in the theory of functions and functional analysis; D. P. Zhelobenko, On the scientific work of M. A. Naimark; V. P. Korobeinikov, Mathematical problems of mechanics at the Mathematical Institute of the Academy of Sciences; A. G. Kulikovskii, Strong discontinuities in flows of continuous media, and their structure.

1980 Mathematics Subject Classifications: 01A60, 01A65, 01A70, 01A74, 04-03, 04A15, 22-03, 22E46, 34-03, 34K20, 41-02, 41A05, 41A10, 41A17, 41A25, 41A27, 41A44, 41A46, 41A54, 41A63, 42-03, 42A16, 42A20, 42A24, 42A28, 42C10, 42C15, 42C20, 46-02, 46-03, 46E15, 46E35, 46L05, 47-03, 47B50, 60-02, 60B12, 60F05, 60G25, 62E99, 62M10, 73-02, 73C02, 76-02, 76B99, 76L05, 93E10; 26A15, 26A16, 26B35, 26B40, 26D10, 35J05, 35J40, 35J70, 41A15, 41A17, 41A30, 41A50, 41A55, 41A80, 42A10, 42A32, 42A55, 46E30, 46E40, 46F99, 60-03, 60B11, 60G10, 60G15, 60G35, 60H15, 62C10, 62F04, 62L10, 62L15, 62M20, 73C02, 73E99, 76B05, 76B10, 76B15, 76J10, 76L05, 76N15, 76S05, 76W05, 78A25, 86A10, 93E11

ISBN 0-8218-3132-1, LC 90-513, ISSN 0081-5438

318 pages (hardcover), May 1990

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FIFTEEN PAPERS IN COMPLEX ANALYSIS

L. A. Aizenberg, A. B. Aleksandrov, P. V. Degtyar', Ya. Yu. Gaidis, S. G. Gindikin, V. A. Kakichev, V. P. Khavin, G. M. Khenkin, B. I. Odvirko-Budko, A. L. Onishchik, S. I. Pinchuk, A. Yu. Pushnikov, V. V. Rabotin, L. I. Ronkin, A. Sadullaev, N. N. Tarkhanov, A. K. Tsikh, A. P. Yuzhakov

(American Mathematical Society Translations, Series 2, Volume 146)

The papers in this volume range over a variety of topics in complex analysis, including holomorphic and entire functions, integral representations, the local theory of residues, complex manifolds, singularities, and CR structures.

Contents

L. A. Aizenberg, Multidimensional analogues of Carleman's formula with integration over boundary sets of maximal dimension; A. B. Aleksandrov, Blaschke's condition and the zeros of bounded holomorphic functions; Ya. Yu. Gaidis and S. G. Gindikin, On an algebraic cone in C^6 connected with rational curves; S. G. Gindikin and G. M. Khenkin, The Cauchy-Fantappiè formula on projective space; V. A. Kakichev, Application of the Fourier method to the solution of boundary value problems for functions analytic in disk bidomains; A. L. Onishchik, On the topology of certain complex homogeneous spaces; S. I. Pinchuk and A. Yu. Pushnikov, CR-mappings of manifolds of codimension 2; L. I. Ronkin, Entire functions on C^n that are quasipolynomials with respect to one of the variables; A. Sadullaev and P. V. Degtyar', Defect hyperplanes of holomorphic mappings; N. N. Tarkhanov, On Poincaré duality for elliptic complexes; V. P. Khavin, A remark on Taylor series of harmonic functions; A. K. Tsikh, Use of residues to compute the sum of the squares of the Taylor coefficients of

a rational function of two variables; **A. P. Yuzhakov**, *On the separation of analytic singularities and the decomposition of holomorphic functions of n variables into partial fractions*; **B. I. Odvirko-Budko**, *Some multidimensional estimates of conditional stability in the problem of analytic continuation from a subdomain of the domain of regularity*; **V. V. Rabotin**, *A counterexample to two problems of Kobayashi*.

1980 *Mathematics Subject Classifications*: 14C21, 14N05, 30C15, 30E25, 31B05, 32A07, 32A10, 32A15, 32A25, 32A27, 32A30, 32C10, 32C40, 32D99, 32G07, 32H30, 32L25, 32M10, 35Q15, 41A58, 57P10, 57T15, 58G05; Secondary 14F05, 30D15, 30D50, 31B15, 31B20, 32A22, 32C05, 32C30, 32D15, 32F05, 42B20, 53A20, 53A60, 53C30, 55U25

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The following publication originally appeared in the February 1990 *Notices*. It is being reprinted here with the correct author names.

SOCIÉTÉ MATHÉMATIQUE DE FRANCE, ASTÉRISQUE

The AMS distributes Astérisque only in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF, B.P. 126-05, 75226 Paris Cedex 05, France, or to OFFILIB, 48 rue Gay-Lussac, 75240 Paris Cedex 05, France. Individual members of either AMS or SMF are entitled to the member price. (ISSN 0303-1179)

LA PROPRIÉTÉ (T) DE KAZHDAN POUR LES GROUPES LOCALEMENT COMPACTS

P. de la Harpe and A. Valette

(Astérisque, Number 175)

A locally compact group G is said to have Kazhdan's property (T) if any isometric affine action of G in a Hilbert

space has a fixed point. Typical examples of non compact groups with property (T) are $SL_n(\mathbb{R})$, $SL_n(\mathbb{Z})$ and $SL_n(\mathbb{Q}_p)$ for $n \geq 3$. The purpose of these notes is to show several equivalent definitions of this property, to give a large number of examples, and to point at several nice applications to discrete subgroups of Lie groups as well as to various problems of geometry and graph theory.

TABLE DES MATIÈRES

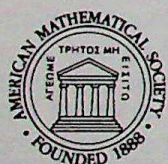
Définitions et premières conséquences; Principaux exemples: groupes de Lie: Le cas de $SL_n(\mathbb{R})$; Autres groupes de Lie simples à centres finis; Propriété (T) et revêtements; **Principaux exemples:** groupes discrets: Sous-groupes de Kazhdan d'un groupe de Kazhdan; Centre d'une partie bornée dans un espace métrique où l'inégalité de la médiane est vraie; A propos d'un théorème de Wang. Exemples de Serre et de Gromov; **Définition cohomologique de la propriété (T):** Propriété (FH) de propriété (T); La famille $(\mathcal{H}_t)_{t>0}$ associée à un espace de Hilbert affine; **Propriété (T), fonctions de type positif et fonctions conditionnellement de type négatif:** Noyaux de type positif; Noyaux conditionnellement de type négatif; **Applications géométriques:** Arbres; Arbres réels; Complexes de Coxeter; Espaces hyperboliques; **Le problème de Ruziewicz:** Un problème de centraux téléphoniques: $Sp(1, n)$ est un groupe de Kazhdan ($n \geq 2$); Preuve du théorème A; Preuve du théorème B; **Algèbres d'opérateurs.**

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UNFOLDINGS AND BIFURCATIONS OF QUASI-PERIODIC TORI

H. W. Broer, B. Huitema, F. Takens, and B. L. J. Braaksma

(Memoirs of the AMS, Number 421)

In the theory of dynamical systems, the occurrence of equilibria and periodic motions, as well as their general persistence and stability properties, are now fairly well understood. Researchers also have some systematic insight into the role of external parameters. This book aims to mimic this classical theory in the case of quasi-periodic motions. These motions are most familiar in the context of the conservative dynamics of classical mechanics, but they also occur with dissipative dynamics—for example, quasi-periodic attractors play a role in the onset of turbulence.

In the first part of the book, the authors present a general treatment of the use of external parameters in various contexts, employing notions such as integrability and transversality. The second part, dealing only with dissipative cases, studies bifurcations when the hyperbolicity is mildly violated. Readers will appreciate the way the book systematically ties together a number of cases for quasi-periodicity and the resulting improvement of accuracy. In addition, a number of new applications are presented.

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NEW SERIES

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CONFERENCE BOARD OF THE MATHEMATICAL SCIENCES

Issues in Mathematics Education

The AMS is pleased to announce a new book series: The Conference Board of the Mathematical Sciences (CBMS): Issues in Mathematics Education Series published in cooperation with the Mathematical Association of America. The purpose of this new series is to stimulate the flow of information among mathematical scientists, mathematics educators, and mathematics teachers about innovative efforts to revitalize the teaching of mathematics and statistics at all levels. The inaugural volume of CBMS Issues in Mathematics Education is described below. Standing orders are accepted for any book series published by the Society. Proforma invoices are sent to standing order customers prior to the publication of each new volume. Shipment is made upon receipt of payment and publication. To begin a standing order for this new series or for any other AMS series, please contact Customer Services.

MATHEMATICIANS AND EDUCATION REFORM

Naomi Fisher, Harvey Keynes, and Philip Wagreich, Editors

(CBMS Issues in Mathematics Education, Volume 1)

Educational issues are receiving unprecedented attention in the broad mathematical sciences community, as mathematicians and other scientists have become concerned about the quality of instruction in the nation's schools, colleges, and universities. A mathematically literate population is crucial to supporting our increasingly technological society. In addition, the mathematical sciences community faces the challenge of increasing the number of students who are prepared to pursue a career in mathematics, science, or engineering. This challenge requires not only raising the quality of mathematics education, but also showing students the beauty and usefulness of the subject. In these ways, mathematical scientists can make crucial contributions to educational reform.

In response to these concerns, the Conference Board of the Mathematical Sciences has launched a new book series published by the American Mathematical Society in cooperation with the Mathematical Association of America entitled Issues in Mathematics Education. The purpose of this new series is to stimulate the flow of information among mathematical scientists, mathematics educators, and mathematics teachers about innovative efforts to revitalize the teaching of mathematics and statistics at all levels.

The present volume, *Mathematicians and Education Reform*, the first in this new series, contains the proceedings of the Mathematicians and Education Reform workshop held in July 1988, at the University of Illinois at Chicago. The workshop provided an opportunity for participants to share ideas about the various ongoing pre-college projects organized and directed by mathematicians and to reflect on the most effective ways that mathematicians can contribute to educational reform. The major part of the proceedings is devoted to in-depth articles that explore the process of designing an educational project. A section on issues and reactions presents a forum for exchanging ideas on more general issues.

From practical information about organizing a program to exploration of the intellectual issues of educational reform, this volume presents a range of views on various aspects of the involvement of mathematicians in educational change. While it will prove especially useful for those considering involvement in an educational program, this book is also important reading for the entire community, for the issues explored here will be of increasing importance for the future of the mathematical sciences.



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AMS Reports and Communications

Recent Appointments

Committee members' terms of office on standing committees expire on December 31 of the year given in parentheses following their names, unless otherwise specified.

William Chinn, Guy M. De Primo, Judith Ekstrand, Millianne Lehman, Peter S. Pacheco, Franklin Sheehan, and Tom Walsh have been appointed by Presidents William Browder (AMS) and Lida K. Barrett (MAA) to the AMS-MAA *Arrangements Committee for the San Francisco Meeting*. Continuing members of the committee are Newman Fisher, chair, William H. Jaco (ex officio), Kenneth A. Ross (ex officio), and Andy Roy Magid (ex officio).

Andrew J. Majda (1992) has been appointed by Presidents William Browder (AMS) and Ivar Stakgold (SIAM) to the AMS-SIAM *Committee on Applied Mathematics*. Continuing members of the committee are James M. Hyman (1990), Lawrence A. Shepp (1991), Joel Spencer (1992), Gilbert Strang (1991), and Robert F. Warming (1990).

The April Meeting in University Park

The 857th meeting of the American Mathematical Society was held at the Pennsylvania State University in University Park, Pennsylvania, on Saturday and Sunday, April 7-8, 1990. There were 127 registrants, including 116 members of the Society.

The Society met jointly with the Association for Symbolic Logic, and in conjunction with the Allegheny

Mountain Section of the Mathematical Association of America.

Invited Addresses. By invitation of the Eastern Section Program Committee, there were four invited addresses. The speakers, their affiliations, and the titles of their talks, were as follows: ROBERT T. GLASSEY, Indiana University, *On collisionless plasmas and the Vlasov-Maxwell equations*; KARSTEN GROVE, University of Maryland, *Geometry and topology of manifolds curved from below*; LOWELL JONES, SUNY at Stony Brook, *Rigidity for non-positively curved manifolds*; GANG TIAN, Princeton University, *Einstein metrics on algebraic manifolds*.

The four speakers were introduced by W. Wistar Comfort, Thomas Farrell, Steve Armentrout, and Wolfgang Ziller, respectively.

Special Sessions. By invitation of the same committee, there were four special sessions of selected 20-minute papers. The topics of these sessions, and the names and affiliations of the organizers, were as follows:

Classical and quantum groups, RANEE KATHRYN BRYLINSKI, Pennsylvania State University.

Algebraic topology, DONALD M. DAVIS, Lehigh University.

Geometric topology, THOMAS FARRELL, Columbia University.

Recent progress on Einstein manifolds and related topics, GANG TIAN, Princeton University.

Symposium. The Society and the ASL co-sponsored a symposium on Number theory and decidability, with Barry Mazur and Stephen G. Simpson serving as moderators. The panelists were Serge Lang, Angus Macintyre, and Lou van den Dries.

Contributed Papers. There were two sessions for 10-minute contributed papers. Eight mathematicians participated. The sessions were co-chaired by Frank E. Baginski, Edward K. Hinson, T. K. Puttaswamy, and Robert Treger.

Committee. The undersigned Associate Secretary is pleased to thank the Local Arrangements Committee, of which Richard Herman was Chairman, and Norman Lathbury for extensive, effective service.

W. Wistar Comfort
Associate Secretary
Middletown, Connecticut

The Council Meeting in Albuquerque

The Council met at 7:00 p.m. Mountain Daylight Time on 19 April 1990 at the Sheraton Old Town Hotel in Albuquerque, New Mexico. President Browder presided.

It received and adopted the report of its ad hoc Committee on Scheduling and Procedures for Elections. The major points in these procedures were the following:

a. The nomination by petition process will begin in November of the year before the election so that all nominations by petition will be in the Council's hands for its Spring Meeting.

b. The terms of office for members of the Nominating Committee will begin on 01 January of the year after election.

c. The Council will finish with the nomination procedures by the end of its spring meeting.

d. All election material, including biographies and statements of candidates, will appear in the July/August

issue of *Notices*. In those years when a President-Elect is to be elected, this material will also include an article of "nomination" for each candidate for this position. These procedures will become effective for the 1991 election.

The Council received and approved a recommendation from its Editorial Boards Committee to elect Burgess Davis to a three-year term on the *Transactions* and *Memoirs* Editorial Committee.

The Council nominated the slate of candidates for the 1990 Election as recommended by its Nominating Committee. This slate appears in this issue of *Notices* in the 1990 AMS Elections section.

It also considered and approved a report of the AMS-MAA Committee to Search for a new director of the Office of Governmental and Public Affairs. The committee made

a definite recommendation that the Council endorsed.

The three items immediately above were considered while the Council was in executive session.

The Council agreed to make the beginning of the terms of office of the Society's officers 01 February of the year after election, rather than 01 January, which is the case now. It also agreed to change the date when it will elect its member to its Executive Committee. These Bylaws changes will be voted upon by the membership in the Fall 1990 Election.

The Council voted to ask all organizations that sponsor the Committee on Women in the Mathematical Sciences to invite the Association for Women in Mathematics to become a co-sponsor. It changed the name of that section of the Society on the Pacific Rim to the *Western Sec-*

tion from the previous Far Western Section. It also adopted a resolution congratulating the Moroccan Mathematical Society on its foundation (in July 1990).

The Council heard a report from the chair of the Society's Committee on Science Policy, Michael Reed, on the activities of the committee at its meeting in Albuquerque. It also heard a report from the Society's Executive Director.

Finally the Council agreed to appoint a committee to determine whether or not mathematicians will be denied access to Society projects in the Soviet Union on the basis of race, religion, or national origin. This committee will be asked to report to the Council at its next meeting.

The Council adjourned at 11:30 p.m.

Robert M. Fossum
Secretary
Urbana, Illinois

WEAK CONVERGENCE METHODS FOR NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS

Lawrence C. Evans

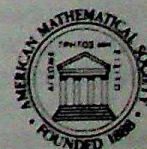
(CBMS Regional Conference Series, Number 74 • Supported by the National Science Foundation)

The purpose of this book is to explain systematically and clearly many of the most important techniques set forth in recent years for using weak convergence methods to study nonlinear partial differential equations. This work represents an expanded version of a series of ten talks presented by the author at Loyola University of Chicago in the summer of 1988.

The author surveys a wide collection of techniques for showing the existence of solutions to various nonlinear partial differential equations, especially when strong analytic estimates are unavailable. The overall guiding viewpoint is that when a sequence of approximate solutions converges only weakly, one must exploit the nonlinear structure of the PDE to justify passing to limits. The author concentrates on several areas that are rapidly developing and points to some underlying viewpoints common to them all. Among the several themes in the book are the primary role of measure theory and real analysis (as opposed to functional analysis) and the continual use in diverse settings of low amplitude, high frequency periodic test functions to extract useful information. The author uses the simplest problems possible to illustrate various key techniques.

Aimed at research mathematicians in the field of nonlinear PDEs, this book should prove an important resource for understanding the techniques being used at the forefront of this vital area of research.

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Miscellaneous

Personal Items

Gove Effinger, of Skidmore College, was one of nine researchers honored in the physical sciences and mathematics category of this year's IBM 3090 Supercomputing Competition.

Ewing L. Lusk, of Downers Grove, has been promoted to scientific director of the Advanced Computing Research Facility (ACRF) at the U.S. Department of Energy's Argonne National Laboratory.

Deaths

Ralph Beatley, Associate Professor Emeritus of Harvard University, died on December 29, 1989, at the age of 97. He was a member of the Society for 66 years.

Lamberto Cesari, Professor Emeritus of the University of Michigan, died on March 12, 1990, at the age of

79. He was a member of the Society for 42 years.

Randal H. Cole, Professor Emeritus of the University of Western Ontario, died on February 11, 1990, at the age of 81. He was a member of the Society for 19 years.

Sister Mary Cleophas Garvin, of Chardon, Ohio, died on January 16, 1990, at the age of 90. She was a member of the Society for 19 years.

Chen Jung Hsu, Research Fellow of the Academia Sinica, died on July 14, 1988, at the age of 70. He was a member of the Society for 37 years.

Frank Kozin, of the Polytechnic Institute of New York, died on April 5, 1990, at the age of 60. He was a member of the Society for 38 years.

Roy R. Kuebler, Jr., Professor Emeritus of the University of North Carolina at Chapel Hill, died on

February 20, 1990, at the age of 78. He was a member of the Society for 44 years.

Edgar R. Lorch, Professor Emeritus of Columbia University, died on March 5, 1990, at the age of 82. He was a member of the Society for 59 years.

Knox T. Millsaps, of the University of Florida College of Engineering, died on December 19, 1989, at the age of 68. He was a member of the Society for 47 years.

Carroll V. Newsom, of Dublin, Ohio, died on February 3, 1990, at the age of 85. He was a member of the Society for 59 years.

Isaac J. Schoenberg, Professor Emeritus of the University of Wisconsin at Madison, died on February 21, 1990, at the age of 86. He was a member of the Society for 59 years.

PRIMES ASSOCIATED TO AN IDEAL

Stephen McAdam

(Contemporary Mathematics, Volume 102)

This book discusses five closely related sets of prime ideals associated to an ideal I in a Noetherian ring: the persistent, asymptotic, quintasymptotic, essential, and quintessential primes of I . Since the appearance of the author's last book on the subject, which focused on the first two of these prime ideals, the other three sets were developed and new results were obtained for the first two. Current results are scattered over some three dozen papers, making it difficult for interested readers to become familiar with the subject.

The aim of this book is to present in an efficient way the most important and interesting ideas in the subject and to show how these prime ideals reveal information about both I and the ring. Because the required background consists of little more than a standard one-year course in commutative ring theory, the book should be accessible to graduate students. The work is primarily intended for commutative ring theorists, but noncommutative ring theorists and algebraic geometers may also find it of interest.

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Visiting Mathematicians

The list of visiting mathematicians includes both foreign mathematicians visiting in the United States and Canada, and Americans visiting abroad. Note that there are two separate lists.

American Mathematicians Visiting Abroad

<u>Name and Home Country</u>	<u>Host Institution</u>	<u>Field of Special Interest</u>	<u>Period of Visit</u>
Casazza, Peter (U.S.A.)	University of Cambridge, England	Banach Space Theory	9/90 - 8/91
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Applications with curriculum vitae and list of publications should be submitted before July 15, 1990 to

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The Department of Mathematics is actively seeking applications in all areas of pure and applied mathematics. Several tenure track positions are available at all levels.

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Applications should be sent to: Professor N. Liron, Chairman, Department of Mathematics, Technion-Israel Institute of Technology, 3200. Haifa, Israel.

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Applications are invited from qualified candidates for temporary assignment in Nakajo, Japan. Appointments will be made for one or two semesters beginning in August 1990. A Ph.D in mathematics is required. Selection will be based on demonstrated excellence in teaching undergraduates through the calculus. Applicants are asked to send a letter of application, curricula vita, three letters of reference (which address the teaching credentials of the candidate) by April 15, 1990 (or until filled) to:

Nakajo Position
c/o Ronald B. Kirk, Chair
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Commencing salary will be established within the ranges \$NZ36,000-\$NZ47,200 per annum.

Conditions of Appointment and Method of Application are available from the Assistant Registrar, Academic Appointments, University of Auckland, Private Bag, Auckland. Applications should be forwarded as soon as possible

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ANNOUNCEMENTS**ANNOUNCEMENT BY THE MATHEMATICAL
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OF THE A.W. TUCKER
PRIZE**

The Mathematical Programming Society invites nominations for the A. W. Tucker Prize for an outstanding paper authored by a student. The award will be presented at the International Symposium on Mathematical Programming in Amsterdam. The Netherlands (5-9 August 1991). All students, graduate and undergraduate, are eligible. Nominations of students who have not yet received the first university degree are especially welcome. In advance of the Symposium an award committee will screen the nominations and select at most three finalists. The finalists will be invited, but not required, to give oral presentations at a special session of the Symposium. The award committee will select the winner and present the award prior to the conclusion of the Symposium. The members of the committee for the 1991 A. W. Tucker Prize are: Richard W. Cottle, Stanford University; Thomas M. Liebling, Swiss Federal Institute of Technology, Lausanne; Richard A. Tapia, Rice University; Alan C. Tucker, State University of New York at Stony Brook.

ELIGIBILITY:

The paper may concern any aspect of mathematical programming; it may be original research, an exposition or survey, a report on computer routines and computing experiments, or a presentation of a new and interesting application. The paper must be solely authored, and completed after January 1988. The paper and the work on which it is based should have been undertaken and completed in conjunction with a degree program.

NOMINATIONS:

Nominations must be made in writing to the chairman of the award committee

Richard W. Cottle
Department of Operations Research
Stanford University
Stanford, California 94305-4022

by a faculty member at the institution where the nominee was studying for a degree when the paper was completed. Letters of nomination must be accompanied by four copies each of: the student's paper; a separate summary of the paper's contributions, written by the nominee, and no more than two pages in

length; and a brief biographical sketch of the nominee.

TEMPLE UNIVERSITY
The Grosswald Memorial Fund

The Mathematics Department of Temple University is pleased to announce the establishment of the Grosswald Memorial Fund, in memory of our late colleague, the distinguished mathematician Emil Grosswald, who died in April, 1989. The fund will be used to establish a research instructorship in Emil Grosswald's name, to forward the tradition of mathematical excellence he did so much to establish at Temple.

Those wishing to contribute to this project may contact: Marvin Knapp, Temple University, Department of Mathematics 038-16, Philadelphia, PA 19122. Contributions are tax deductible.

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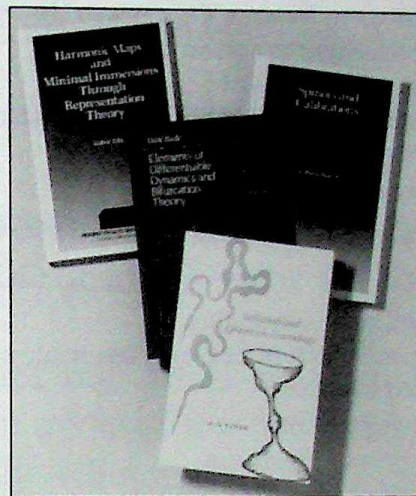
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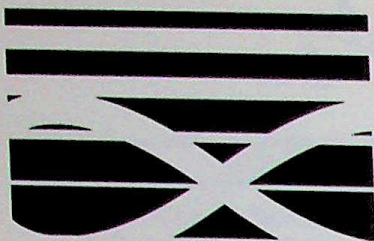
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MATHEMATICAL SCIENCES RESEARCH INSTITUTE

1000 CENTENNIAL DRIVE, BERKELEY, CALIFORNIA 94720

The Institute solicits applications for membership in the Institute for the 1991-92 year, which begins on September 3, 1991. In 1991-92 two programs will be featured. Although these two areas will be emphasized, applications from candidates in all fields will be welcome.

LIE GROUPS AND ERGODIC THEORY WITH APPLICATIONS TO NUMBER THEORY AND GEOMETRY. Topics will include:

1. Flows on homogeneous spaces with applications to number theory.
2. Actions on algebraic homogeneous spaces and boundaries.
3. Smooth actions of semisimple groups and discrete subgroups, with applications to geometric structures.
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5. Non-positively curved manifolds and symmetric spaces.

The program committee consists of H. Furstenberg, M. Ratner, P. Sarnak, and R. Zimmer (Chairman).

STATISTICS. The topics of this program include:

1. Empirical and related processes and applications including
 - a) Gaussian processes and probability on Banach spaces, b) Econometric modelling, c) Neural networks.

The topic organizers are L. LeCam and D. Pollard.

2. Resampling and other computer intensive methods.

The topic organizers are R. Beran, B. Efron, J. Friedman.

3. Nonparametric and semiparametric models and survival analysis.

The topic organizers are P.J. Bickel, R.D. Gill.

In addition there will be two workshops:

4. Statistical methods in imaging to be organized by B. Silverman.

5. Statistical methods in molecular biology to be organized by M. Waterman.

The program committee consists of P.J. Bickel (Chairman), L. LeCam, D. Siegmund and T. Speed.

POSTDOCTORAL FELLOWSHIPS

We anticipate making approximately 20 awards of postdoctoral fellowships. The stipend for 1990-91 is \$30,000 and it will be at least that for 1991-92. In addition there is an award for round trip travel. The candidate's Ph.D. should be 1986 or later. Candidates are asked to solicit three letters of recommendation. Most awards are for a year, but a shorter period is possible. The deadline for applications is November 30, 1990.

SENIOR MEMBERSHIPS

For mathematicians whose Ph.D. is 1985 or earlier, applications are invited for part or all of 1991-92. Letters of recommendation are encouraged but not required. It is generally expected that members at this level will come with partial or full support from other sources. The deadline for applications is November 30, 1990.

RESEARCH PROFESSORSHIPS

Please see the separate announcement of these awards; it will appear both as an advertisement in the AMS Notices and as a poster. There is an earlier deadline for applications: October 1, 1990.

FURTHER REMARKS

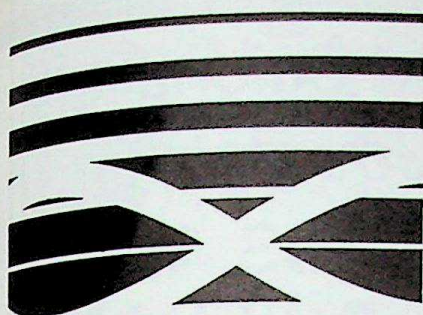
Each application should include an up-to-date vita and bibliography and a statement of research plans.

The Institute does not use formal application forms. However, an information sheet giving additional suggestions to prospective applicants is available upon request. Write to: the Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley CA 94720. Women and minority candidates are especially encouraged to apply.

Candidates are asked to make sure that their application materials and letters of reference arrive by the deadline (October 1, 1990 for Research Professorships and November 30, 1990 for the others). Late applications cannot be assured a complete consideration. Awards will be announced by early December, 1990 for Research Professorships and by mid-February, 1991 for the others.

There will be a program in Mathematical Biology in the summer of 1992; a separate announcement will be issued, probably in the fall of 1990. In 1992-93 there will be three programs: Algebraic Geometry for the whole year, Symbolic Dynamics for the first half of the year, and Transcendence and Diophantine Problems for the second half of the year. Suggestions for future programs are welcome.

The Institute is committed to the principles of Equal Opportunity and Affirmative Action.



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RESEARCH PROFESSORSHIPS

The Mathematical Sciences Research Institute (MSRI) announces the availability of Research Professorships for the academic year 1991-92.

These awards are intended for midcareer mathematicians; the applicant's Ph.D. should be 1985 or earlier. An award for a full academic year will be limited to a ceiling of \$30,000 and normally will not exceed half the applicant's salary. Appointments can be made for a portion of the year; the \$30,000 ceiling and half salary limit would then be prorated. It is anticipated that between six and ten awards will be made.

In addition to the basic stipend, there will be an award for round trip travel to MSRI.

In 1991-92 MSRI will feature two programs: Statistics, and Lie Groups and Ergodic Theory. However, these Professorships are directed to applicants in all fields of the mathematical sciences.

Women and minority candidates are especially encouraged to apply.

MSRI does not use formal application forms. An application should include a vita, a bibliography, a plan of research, and a statement concerning financial requirements. Two letters of reference are required. Candidates are asked to make sure that their application materials and the two letters arrive by October 1, 1990. Late applications cannot be assured a complete consideration. Awards will be announced in early December, 1990.

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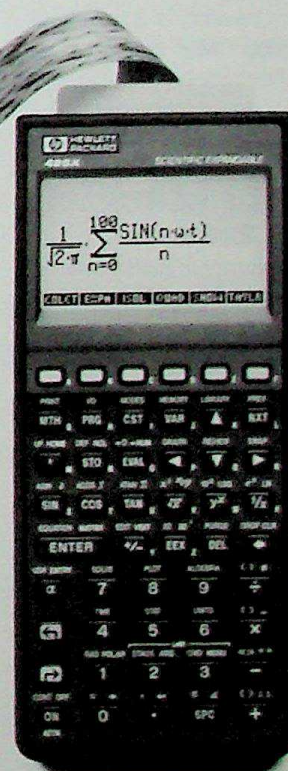
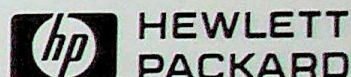
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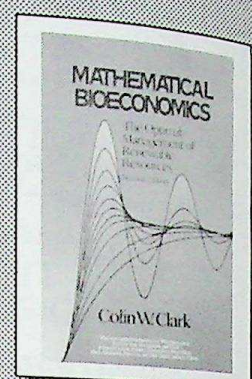
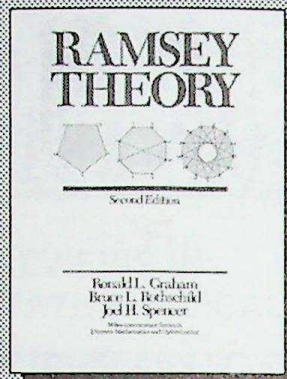
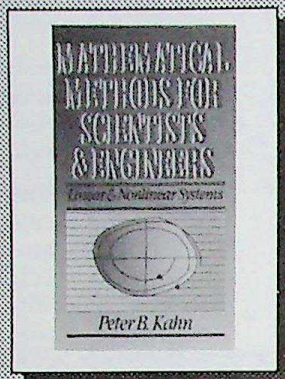
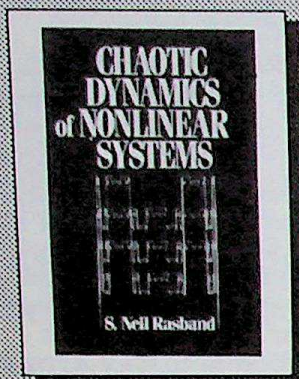
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To obtain a form and guidelines for submitting a minisymposium proposal, please check the appropriate box on the reply form and return it to SIAM promptly.

Deadline date for minisymposia proposals: July 31, 1990

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If you have questions about ICIAM 91, write to:

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Proceedings of the First Conference of the Canadian Number Theory Association held at the Banff Center, Banff, Alberta, April 17-21, 1988

Edited by Richard A. Mollin

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These Proceedings contain forty-five refereed papers in diverse areas of number theory including algebraic, analytic, elementary and computational number theory, elliptic curves, connections with logic, and complexity of algorithms. The volume will be of interest to computer scientists as well as number theorists and research mathematicians in general.

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Steve Fisk

(Contemporary Mathematics, Volume 103)

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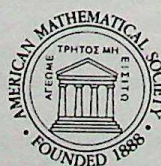
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Recent Developments in Geometry

S.-Y. Cheng, H. Choi, and Robert E. Greene, Editors
(Contemporary Mathematics, Volume 101)

This volume is the outgrowth of a Special Session on Geometry held at the November 1987 meeting of the AMS at the University of California at Los Angeles. The unusually well-attended session attracted more than sixty participants and featured over forty addresses by some of the day's outstanding geometers. By common consent, it was decided that the papers to be collected in the present volume should be surveys of relatively broad areas of geometry, rather than detailed presentations of new research results. A comprehensive survey of the field is beyond the scope of a volume such as this. Nonetheless, the editors have sought to provide all geometers whatever their specialties, with some insight into recent developments in a variety of topics in this active area of research.



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Letters to the Editor

Human Rights of Mathematicians in the U.S.S.R.

While the situation of Jews in the Soviet Union has changed considerably, and many more can leave, there is ample cause for alarm. Numerous newspaper reports of anti-Semitic incidents rouse concern. But not so well known is the continuation of certain discriminatory practices in academic circles—under glasnost and perestroika.

I recently learned about 4 mathematicians who were not granted Ph.D.'s by the Council of Mathematics and Mechanics of Moscow State University. This is Council No. 1, responsible for Analysis, Probability and Differential Equations. The people involved are (names in parenthesis are advisors): I. M. Belenkii, 1989 (Gorin); O. Immanvilov, 1986 (Fursikov); M. Blanc, 1986 (Sinai); and B. Shapiro, 1989 (Arnold).

In the last case, at the meeting of the council, the official opponent made only positive remarks about the thesis, and no one had anything negative during the ensuing discussion. Nevertheless when the (secret) vote was taken, then and there, the thesis was voted down. Later Arnold resigned from the council stating that he did not wish to serve with people who make decisions on other than scientific grounds.

It is clear to many of our Soviet colleagues that these four people were turned down because of anti-Semitism. Apparently it is common practice for the council—though not permissible according to its rules—to have “dead present voting”. That is, if a member of the council is not present, and has not designated someone to vote for him or her, then the secretary apparently feels free to arbitrarily assign someone to do it.

Last fall, for the first time in many years, a good number of young Jewish students was admitted to study Mathematics at the University. I was told that the entrance examination system had been changed to be more fair and to reduce the incidence of discrimination. A welcome development! But I have just learned that the Mathematics examining committee recently voted to go back to the old system.

Louis Nirenberg
New York University
(Received May 14, 1990)

Mathematics Outside of Mathematics Departments

The depressing situation documented in the article ‘Mathematics Outside of Mathematics Departments’, by S. Garfunkel and G. Young, in the April 1990 *Notices* is, in my view, a symptom of deeper effects. While there has been in recent years much lip-service to the desirability of greater involvement of mathematics in science and engineering, there has not been a commensurate commitment of institutional energy and money. For example, my own field of Differential Geometry has had great intellectual success in fields such as Physics, Mechanics and Control — and I am now working on possibilities in Computer Science — but I do not see support by the mathematical world for development of courses, textbooks, research institutes, etc. to make available to students material they would need to understand the new and difficult mathematical insights. Instead, much of the activity which has taken place has been that of most concern and benefit to existing mathematical interests, or that has had publicity due to the entrepreneurial energy of certain players.

Robert Hermann
Brookline, Massachusetts
(Received April 23, 1990)

Graduate Education in Mathematics

With great interest I read the article by Allyn Jackson, “Graduate

Education in Mathematics” (*Notices*, March 1990, page 266 ff). I wish to make some brief comments. First, what Ivar Stakgold has done is revive the discussion that led to the institution of the D.A. degree back in the late 60s and early 70s. Although he does not want to “revive” the D.A. (I didn’t know it had fainted or died), he is nonetheless calling for the equivalent.

Second, I disagree with Jackson’s remark that the D.A. “was created at a time when many feared a shortage of mathematicians to fill faculty vacancies”. The D.A. was created for the very reason that Stakgold gives when he calls for a second track in the doctoral program.

Third, the reason the D.A. “never really caught on” was because there was some suspicion that the D.A.

Policy on Letters to the Editor

Letters submitted for publication in *Notices* are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule normally requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of *Notices* in which it could appear.

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wasn't the genuine article. This was (and is) an unfortunate suspicion. I will only say that D.A. mathematicians do continue to distinguish themselves as faculty members and scholars every bit as much as most Ph.D. mathematicians.

Don Muench
St. John Fisher College
(Received April 9, 1990)

This refers to the article, "Graduate Education in Mathematics" (*Notices*, March 1990, pages 266-268), highlighted on the issue cover.

There is a problem with the article, and a fundamental one: the title refers to education, while the text itself deals with training (subtitles: Traditional training, Postdoctoral training; phrases: students are still trained, Ph.D. training, research training, etc.) There is a difference; e.g., as in institute of higher education, I am an educator, as contrasted e.g. with sea-lion training, training in the maintenance and repair of the 1960 Dodge Monaco, teacher training college (see, for instance, the concise edition of the OED). It is impossible to train a mathematician (the result is not a mathematician), while it is sometimes possible to educate one - but one must know what one is doing.

I suspect that one of the main sources of the current problems with education, and higher education in particular, in the U.S.A. is this very confusion: schools confine themselves to providing training only, in lieu of an actual education; and the "educators" do not know the difference. For example, math anxiety is an infectious disease spread by bad teachers; and these very teachers were short-changed, and provided with training only, instead of being educated.

My objection to the article is, therefore, not the choice of terms used, but a factual one: that the article really is concerned with training and not education; and, thus, con-

tributes to the (un-addressed) problem rather than to its solution.

Otomar Hájek
Case Western Reserve University
(Received April 16, 1990)

Mentoring

For many years, young mathematicians have been able to get an early start on their own ideas, unlike some sister sciences where beginners in a laboratory work almost as laboratory assistants on the professor's problem, and where every publication has the lab directors name at the start—whether or not the idea came from the director. This is often the fate of Post-docs in these fields, while in mathematics a young Post-doc can pursue his own ideas with advice or stimulus as he deems best.

The November issue of *Notices*, prominently on the second page (1146), seems to argue that Post-docs in mathematics should be reduced to the condition of partial servitude common in other fields, and that each Post-doc needs a "mentor". But let the author (and others equally misinformed) note that mentor is a noun and not a verb. There can be no "mentoring".

Postscript: It has just now appeared that the otherwise excellent David II report, "Renewing U.S. Mathematics: A plan for the 1990s", from the Board on Mathematical Sciences, National Research Council, presents a related version of these unfortunate ideas. On page 64, the reprint speaks of work which "extends beyond the doctorate for additional training" (as if we were training TV repairmen or circus performers). Finally, page 66 mentions "mentoring". There is a better established activity, called "directing thesis work".

Saunders Mac Lane
The University of Chicago
(Received May 15, 1990)

Confidentiality

The Supreme Court, in a decision on a case against the University of Pennsylvania by the Equal Employment Opportunity Commission, has

ruled that confidential scholarly assessments of the work of a candidate for tenure at a university must be disclosed to federal investigators.

This step is a clear violation of confidentiality, basic to the maintenance of racism, sexism, anti-Semitism, etc. at universities. In consequence, I will therefore take more care to be honest in my written evaluations so that all candidates for tenure, or new positions, will be accorded an equal opportunity. I recommend that my colleagues decline to respond to telephone inquiries about the "real" story about people for whom they have written letters when they are being given the opportunity to make racist, sexist, anti-Semitic, etc. comments "off-the-record".

I recommend this action as the only proper response to this attack on undemocratic behavior in our profession.

William J. Pervin
University of Texas at Dallas
(Received April 18, 1990)

Saunders Mac Lane (*Notices* Letters to the Editor, April 1990) recommends declining to write letters to universities about the work of candidates for tenure. This is in light of the Supreme Court's decision requiring disclosure of tenure review files to federal officers in an investigation by the EEOC. (UNIVERSITY OF PENNSYLVANIA, petitioner v. EQUAL EMPLOYMENT OPPORTUNITY COMMISSION. No. 88-493. Jan. 9, 1990.)

In its decision the court declined to "expand" the First Amendment right of academic freedom and declined to "create a new privilege against disclosure of peer review materials" that was not already created by Congress. Justice Blackmun wrote the opinion in the unanimous decision of a court that is not known as an avid supporter of affirmative action or of the civil rights movement.

Professor Mac Lane refers to the court's decision as a "violation of

Letters to the Editor

confidentiality" and an "attack on academic freedom." However, the court did not provide criteria for selection of teachers nor prevent the university from using any criteria of its own other than that of sex, race or national origin. I was an active member of AAUP for many years defending academic freedom and I see no attack on it here.

As for a "violation of confidentiality" I would be surprised if Professor Mac Lane does not know that in many universities the "confidential" letters he's talking about may be seen by every tenured associate and full professor in the department. I have read many of them. They must be read by everyone on the tenure committee and everyone in the university that is involved in the tenure decision. How is it a "violation of confidentiality" if an additional few members of a duly constituted commission see them in a properly prepared case of alleged discrimination?

By law (with criminal penalties) no officer or employee of the EEOC may make public in any manner whatever any information obtained by the Commission prior to formal proceeding.

The importance of confidentiality must be weighed against the extremely high costs to the university and to society of racial and sexual discrimination.

It appears that the main reason for confidentiality is to assure candor. Justice Blackmun wrote, "we are not so ready as petitioner seems to be to assume the worst about those in the academic community. Although it is possible that some evaluators may become less candid as the possibility of disclosure increases, others may simply ground their evaluations in specific examples and illustrations in order to deflect potential claims of bias or unfairness. Not all academics will hesitate to stand up and be counted when they evaluate their peers."

I urge Professor Mac Lane to reconsider his decision not to write

evaluations and his recommendation for others to follow suit.

(All quotations and references to laws are from West's Supreme Court Reporter, vol. 110 No. 7, Feb. 1, 1990.)

Jack Tull

The Ohio State University

(Received April 24, 1990)

I was very disappointed to read the letter by Saunders Mac Lane in the April 1990 issue of *Notices*, regarding the recent Supreme Court decision about the confidentiality of scholarly assessments of the work of tenure candidates.

I am sorry that Professor Mac Lane finds this unanimous decision of the Supreme Court, which was supported by the American Civil Liberties Union, to be an "attack on academic freedom". I thought that academic freedom referred to the right of professors to study and write about topics of their choice without fear of reprisal, and that the granting of tenure was intended to protect these individual rights. In other words, the principal constitutional defense of academic freedom is the protection of free speech by the First Amendment. The decision of the Supreme Court in no way compromised these rights. On the contrary, the decision reaffirmed the rights of individual scholars under the First and Fourteenth Amendments. That is, as a consequence of this decision, scholars in tenure-track positions should feel more confident that they can work on problems that they find interesting without fear that they will be punished later for reasons unrelated to the quality of their work. The Court's decision makes it more difficult for universities to reject tenure candidates because of reasons related to gender, race, etc. Moreover, this decision has a direct bearing on work in certain academic fields - consider the situation of a female historian or literary critic who wishes to base her work on feminist

I am also, frankly, offended by the implications of Professor Mac Lane's claim that "confidentiality [is] basic to the maintenance of quality." Can evaluators not justify the assessments they make in letters about tenure candidates? Are their judgements based on criteria other than the quality of the candidate's work? Do they have something to hide? I don't believe so; I certainly hope not. But it is, in fact, the case that women and minorities are under-represented in mathematics: can we prove that we are not at fault?

Confidentiality does serve at least one goal: collegiality. Someone's feelings might be hurt by another's evaluation of his/her scholarly ability. Friendships might suffer. I can see how this might lead people to be less willing to write unfavorable letters of recommendation, knowing there was some chance that they might become public. (At this point, however, the decision of the Supreme Court only releases the letters to federal investigators for the Equal Employment Opportunity Commission in cases where they feel the letters are necessary to assess the validity of claims of discrimination.) But I claim, nevertheless, that the quality of universities will not suffer. It is easy to differentiate between a letter which lends unqualified support to a candidate and a letter which merely avoids saying anything detrimental. Top candidates will still get the top jobs and will still get tenure at the top universities.

I hope that Professor Mac Lane will reconsider his decision no longer to write letters about tenure candidates. These letters still serve important goals. They are a service to candidates as well as to universities. It would be unfortunate if the mathematical community were deprived of the benefits of his perspective.

Kevin R. Coombes
University of Michigan
(Received May 1, 1990)

1989 Annual AMS-MAA Survey

(Second Report)

Enrollments, Faculty Characteristics,
and Update on New Doctorates, Fall 1989
Edward A. Connors

Highlights

1. The final (spring) count of new doctorates in the mathematical sciences records 419 U.S. citizens among the 919 recipients of doctorates granted by U.S. institutions from July 1, 1988 through June 30, 1989. These U.S. citizens account for only 46% of the new mathematical sciences doctorates awarded by U.S. institutions.
2. The number of U.S. citizens receiving doctorates in 1988-1989 is less than 60% of the comparable number for a range of years in the mid-1970s.
3. Women received 24% of the doctorates in mathematical sciences awarded to U.S. citizens. This is the largest percentage ever and a significant increase over the 20-21% awarded in the last six years. The 100 doctorates awarded to women U.S. citizens in 1988-1989 is exceeded only by the 102 awarded in 1980-1981.
4. Slightly less than 1.5% of the fall 1988 full-time faculty in the mathematical sciences, Groups I, II and III combined, retired or died by the fall of

1989. (See box on this page for descriptions of the groupings used in this Survey.) Slightly less than 1.75% of the fall 1988 full-time faculty in Groups M and B retired or died by fall 1989.

5. One-third of the current full-time faculty at departments that responded to the Survey will have died or reached age 65 by the year 2005.
6. A substantial portion of the upper division (junior/senior) mathematics majors are women: 46% in each of Groups M and B, 39% in Groups I, II and III combined.

Groups I and II include the leading departments of mathematics in the U.S. according to the 1982 assessment of Research-Doctorate Programs conducted by the Conference Board of Associated Research Councils in which departments were rated according to the quality of their graduate faculty.¹

Group I is composed of 39 departments with scores in the 3.0-5.0 range.

Group II is composed of 43 departments with scores in the 2.0-2.9 range.

Group III contains the remaining U.S. departments reporting a doctoral program.

Group IV contains U.S. departments (or programs) of statistics, biostatistics and biometrics reporting a doctoral program.

Group V contains U.S. departments (or programs) in applied mathematics/applied science, operations research and management science which report a doctoral program.

Group Va is applied mathematics/applied science; **Group Vb** is operations research and management science.

Group VI contains doctorate-granting departments (or programs) in the mathematical sciences in Canadian universities.

Group M contains U.S. departments granting a master's degree as the highest graduate degree.

Group B contains U.S. departments granting a baccalaureate degree only.

¹ These findings were published in *An Assessment of Research-Doctorate Programs in the United States: Mathematical and Physical Sciences*, edited by Lyle V. Jones, Gardner Lindzey, and Porter E. Coggeshall, National Academy Press, Washington, D.C., 1982. The information on mathematics, statistics and computer science was presented in digest form in the April 1983 issue of *Notices*, pages 257-267, and an analysis of the above classifications was given in the June 1983 *Notices*, pages 392-393. For a listing of departments in Groups I and II see April 1988 *Notices*, pages 532-533.

A first report of the 1989 Survey appeared in the November 1989 *Notices*, pages 1155-1188, with corrections in the December 1989 *Notices*, page 1372. It included a report on the 1988-1989 new doctorates, starting salaries, faculty salaries, and a list of the names and thesis titles of the 1988-1989 doctorates. A supplementary list of 1988-1989 doctorates appeared in the May/June issue of *Notices*.

The 1989 Annual AMS-MAA Survey represents the thirty-third in an annual series begun in 1957 by the Society. The 1989 Survey was under the direction of the AMS-MAA Committee on Employment and Educational Policy (CEEP), whose members were: Donna L. Beers, Morton Brown, Stefan A. Burr, Edward A. Connors (chair), Philip C. Curtis, Jr., David J. Lutzer, and James J. Tattersall. The questionnaires were devised by CEEP's Data Subcommittee whose members were: Edward A. Connors (chair), Lincoln K. Durst (consultant), John D. Fulton, James F. Hurley, Charlotte Lin, Don O. Loftsgaarden, David J. Lutzer, James W. Maxwell (ex officio), Donald E. McClure, and Donald C. Rung. As of January 1990 the subcommittee became a standing AMS-MAA committee. Comments or suggestions regarding the Annual Survey may be directed to members of the new AMS-MAA Data Committee.

I. Introduction

We present several items of general and specific interest to the mathematical community and its observers. Our analysis is based on the data gathered in the 1989 Annual AMS-MAA Survey. As is customary we begin with an update on the employment status of the 1988-1989 class of new doctorates in the mathematical sciences. We then turn our attention to some of the information obtained from the departmental responses to the Departmental Profile Survey, and to the distribution of faculty by age section of the Faculty Status Survey. The data on faculty age is a new feature which we intend to repeat on a regular basis, perhaps biennially. We have discontinued our collection and analysis of faculty flow and mobility data (to the delight, undoubtedly, of numerous departmental assistants, heads, chairs, and, to be sure, of this author).

As in last year's report, we choose not to extrapolate from the raw data and thus we do not provide estimates of various faculty populations or course enrollments. Instead, we focus on faculty retirement and death rates (Table 3A), faculty composition by sex (Tables 3B and 3C), percentage change in faculty composition (Tables 3D and 3E), faculty age distribution (Table 3F and Figures 1-6), percentage changes in enrollments from fall 1988 to fall 1989 (Tables 4A and 6), undergraduate enrollment distribution patterns (Table 4B), percentages of women among junior/senior mathematics majors and graduate students (Tables 5 and 7), and percentages of U.S. citizens among graduate students (Table 8). The 1990 Survey of the Conference Board on the Mathematical Sciences (CBMS) will provide hard estimates of various faculty populations and course enrollments in the mathematical sciences, based on data gathered for fall 1990.

Finally we direct your attention to the information on response rates at the end of this report, and to the bibliography, which is a comprehensive and current compendium of references on data sources and recent reports in the mathematical sciences, science and engineering.

II. Update on the 1988-1989 New Doctorates

In the First Report of this Survey (November 1989 issue of *Notices*, pages 1155-1168) we reported a fall count of 904 new doctorates in the mathematical sciences granted by U.S. universities (since then increased to 905 because of a late departmental correction). We now update the fall counts to produce the 1988-1989 spring counts: 919 doctorates in the mathematical sciences awarded by U.S. institutions, and 62 awarded by Canadian institutions. Table 1.

Of the 919 doctorates awarded by U.S. universities, citizenship status was reported as known for 896, 419 of whom were U.S. citizens (319 men and 100 women). The 62 Canadian doctorates went to 54 men and 8 women.

TABLE 1: New Doctorates, Fall and Spring Counts

	84-85		85-86		86-87		87-88		88-89	
	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring	Fall/Spring
U.S.	732	765	756	782	779	808	804	828	905*	919
Canada	37	42	45	45	66	66	52	55	53	62
Total	769	807	801	827	845	874	856	883	958*	981

*Increased from the fall count reported in the November 1989 *Notices*.

Employment data for new doctorates are updated in Tables 2A, 2B and 2C. We do not, however, include the additional new doctorates in our updated employment matrices. 18% of the new doctorates reported taking foreign academic or nonacademic employment (compared to 20% for 1987-1988 doctorates). By spring 1990 7% of new doctorates were either not seeking employment, were not yet employed, or their status was unknown (compared with 5% for 1987-1988 doctorates in the spring of 1989). 11.5% of the new doctorates were hired by Group B institutions (compared with 8% for 1987-1988 doctorates, and an average of 8.6% for the previous six years).

The research fields of the new doctorates continue to have an applied flavor (see Table 2C). For the last seven years half, or nearly half, of the new doctorates specialized in statistics, applied mathematics, operations research or computer science. 27% of the 1988-1989 new doctorates reported statistics as the field of thesis.

Finally, we note that the names of the 1988-1989 new doctorates and their thesis titles were published in *Notices* (November 1989 issue and a supplemental list in the May/June 1990 issue).

III. Faculty Characteristics

Two separate surveys provide the data reported in this section. Tables 3A through 3D are produced by responses to the Departmental Profile Survey conducted in fall 1989; Table 3F and Figures 1-5 are produced by responses to the Faculty Status Survey conducted in spring 1989.

In Table 3A we provide the attrition rates of full-time faculty in the mathematical sciences. The numbers we report are obtained from the departmental response to our request for the number of full-time faculty in fall 1988 as well as the number of these who had permanently retired or died by fall 1989. Note the differences among Groups I, II and III (comparable rates in last year's report were 1.26%, 1.65% and 1.76% respectively). Groups I, II and III combined yield a rate of 1.43% (compared to 1.57% last year). The 1.72% for Groups M and B combined is the same as last year's rate.

In last year's report we promised to "ascertain more information on age distribution of full-time faculty and thus better analyze the greying of the contemporary mathematical sciences faculty". Our data for 1989 are

**TABLE 2A: Employment Status of 1988-1989 New Doctorates
in the Mathematical Sciences**

Type of Employer	Algebra and Number Theory	Real and Complex Analysis	Geometry and Topology	Logic	Probability and Statistics	Applied Mathematics	Discrete Mathematics and Combinatorics	Numerical Analysis	Linear and Nonlinear Optimization	Other	Total
Group I	15	32	24	8	4	18		3			
Group II	8	8	7	2	5	14	2	1	1	3	107
Group III	11	11	4		10	8	1	5	1	3	48
Group IV	1				32						54
Group V					4	7			1	2	33
Masters	8	18	9	2	14	21	4	3			14
Bachelors	21	21	15	1	19	9	12	1	1	3	83
Two-year Colleges	2	1	2		1	2		1	2	9	110
Other Academic Departments	2		3		25	13	2	5	8	12	9
Research Institutes	3	2	8		6	3		2			70
Government	1	1			9	6				2	26
Business and Industry	1	4	5	4	48	17	1	3	1	1	19
Canada, Academic	2	8	1		12	2	4	1			100
Canada, Nonacademic			1		2	4					30
Foreign, Academic	19	23	20	1	41	28	7	4	6	6	7
Foreign, Nonacademic		2	2	1	5	5		1	3	3	155
Not seeking employment	1	1	3		3	2	1	2			22
Not yet employed (Spring 1990)	3	2	4	1	9	4		2	1	3	13
Unknown	2	8	3	2	8	2		3		1	29
Total	100	142	111	22	257	165	34	37	34	56	958

**TABLE 2B: Employment Status of 1988-1989 New Doctorates
in the Mathematical Sciences
Females Only**

Type of Employer	Algebra and Number Theory	Real and Complex Analysis	Geometry and Topology	Logic	Probability and Statistics	Applied Mathematics	Discrete Mathematics and Combinatorics	Numerical Analysis	Linear and Nonlinear Optimization	Other	Total
Group I	1	3	1	2	1	1					9
Group II	1	3	2	1	1	2					10
Group III	2		1		2			1	1		7
Group IV					8						8
Group V					1	2				1	4
Masters	2	5	2	1	4	5	1				20
Bachelors	6	3	5		4	8	7			5	38
Two-year Colleges	2	1			1						4
Other Academic Departments					7	3		1	2	1	14
Research Institutes		1			1	1					3
Government					2	1					3
Business and Industry			2		15	1		1	3		22
Canada, Academic			1		3						4
Canada, Nonacademic											
Foreign, Academic		3	5		7	4				1	20
Foreign, Nonacademic											
Not seeking employment			3		1						4
Not yet employed (Spring 1990)		1	1		5			1			8
Unknown					1				1		2
Total	14	20	23	4	64	28	8	4	6	9	180

Table 2C: Fields of New Doctorates

Number (Fall Count) Specialty:	Year Surveyed					
	1983-1984 789	1984-1985 769	1985-1986 801	1986-1987 845	1987-1988 856	1988-1989 958
Applied Math	110 (14%)	115 (15%)	149 (19%)	142 (17%)	142 (17%)	165 (17%)
Statistics	173 (22%)	189 (25%)	171 (21%)	182 (22%)	173 (20%)	257 (27%)
Operations Research	66 (8%)	41 (5%)	62 (8%)	51 (6%)	59 (7%)	34 (3%)
Computer Science	20 (3%)	15 (2%)	16 (2%)	18 (2%)	16 (2%)	37 (4%)
Total	369 (47%)	360 (47%)	398 (50%)	393 (47%)	393 (46%)	493 (51%)

presented in Table 3F and, in graphical form, in Figures 1-5. Similar data for the years 1975 and 1985 for academic Ph.D. scientists and engineers are presented in Figure 6. See also [27] page 64, Figure 5.9, and page 117, Figure A5.9.

Table 3A: Faculty Attrition*

Group	Full-time Faculty %
I	.96
II	1.40
III	1.88
I+II+III	1.43
IV	1.33
V	.73
M	1.75
B	1.69
M+B	1.72

*Percentage of full-time faculty who were in the department in fall 1988 but were reported to have retired or died by fall 1989.

Table 3B: Percentage of Women among Doctoral Full-time Faculty, fall 1989

Groups							
I	II	III	I+II+III	IV	V	M	B
%	%	%	%	%	%	%	%
5.7	7.4	8.0	7.0	11.3	6.8	13.1	16.9

Table 3C: Percentage of Women among all Full-time Faculty, fall 1989

Groups							
I	II	III	I+II+III	IV	V	M	B
%	%	%	%	%	%	%	%
6.5	9.5	12.5	9.5	12.0	6.8	20.0	25.0

Our graphs in Figures 1-5 use 10-year intervals based on age 30, but the raw data are in 5-year spans. Some of the following comments are based on the raw data, which are available for each survey group. Groups I and

V have by far the largest percentage of faculty age 35 or less (25%). The under-30 cohort accounts for 9% of the total faculty in Group I, and 6% in Group V. Group I has the largest percentage of faculty over 60 (13%). In fact, all 5-year age spans from 35-on for Group I hover around 13%, with the largest being 14% in the 45-50 age group. However, this age group (part of the silent generation) accounts for nearly 20% of the total faculty in each of the other survey groups and, indeed, in all survey groups combined. Groups I and V have nearly one quarter of their faculty at age 55. For all groups combined slightly more than one third of the total faculty is age 50 or older and thus will have either died or reached the age of 65 by the year 2005. Likewise, for all groups combined, slightly less than one fifth of the total faculty is age 55 or older.

Table 3D: Percentage Change in Doctoral Nontenured Faculty, fall 1988 to fall 1989

	Groups						
	I	II	III	I+II+III	M	B	M+B
	%	%	%	%	%	%	%
Male	+16	+10	+10	+12	+3	--	+1
Female	+96	+15	+7	+24	+17	+9	+13
Total	+21	+11	+10	+14	+5	+2	+4

Table 3E: Percentage Change in Doctoral Tenured Faculty, fall 1988 to fall 1989

	Groups						
	I	II	III	I+II+III	M	B	M+B
	%	%	%	%	%	%	%
Male	-3	--	-7	-4	+3	+3	+3
Female	-6	--	-3	-4	+7	+2	+4
Total	-3	--	-7	-4	+3	+3	+3

In Figure 3 and Table 3F we provide the age distribution of female faculty in all survey groups combined. Note that only 15% of the female faculty is age 55 or older and that the age 40-45 cohort, at 18% of the total, is the largest (and, in particular, is larger than the 45-50 age group). In Tables 3B and 3C we provide percentages of women among full-time faculty, for doctoral faculty and all faculty respectively.

Table 3F: Age distribution of mathematical sciences faculty, all groups*

	Total Faculty %	Male % of total males	Female % of total females
Under 30	5	5	8
30-35	12	12	15
35-40	13	13	16
40-45	16	15	18
45-50	20	20	15
50-55	15	16	13
55-60	11	11	8
Over 60	8	9	7

* The use of 5-year intervals in this table and 10-year intervals in Figures 1-5 results in slight differences because of rounding.

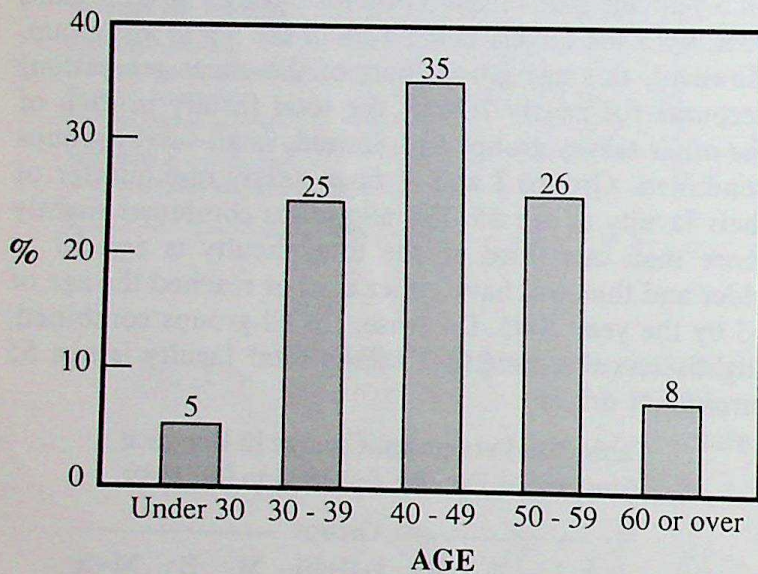


Figure 1. Age distribution of mathematical sciences faculty, all groups.

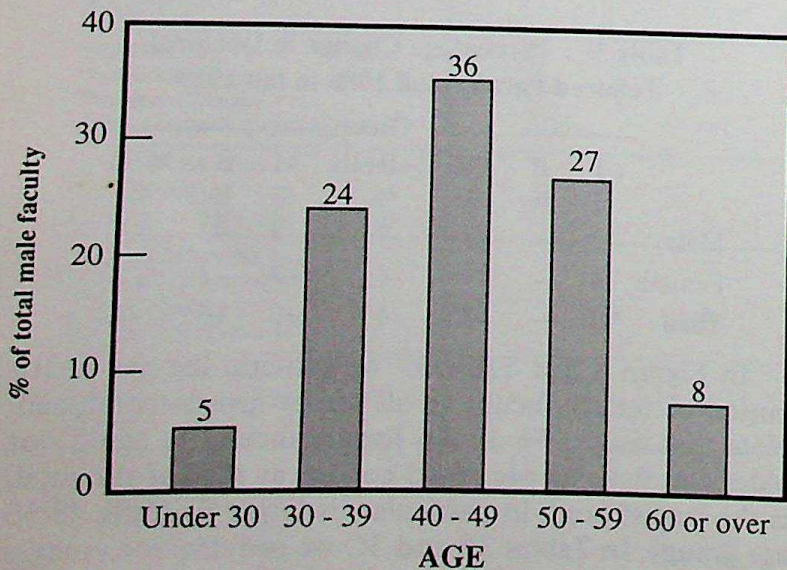


Figure 2. Age distribution of male mathematical sciences faculty all groups.

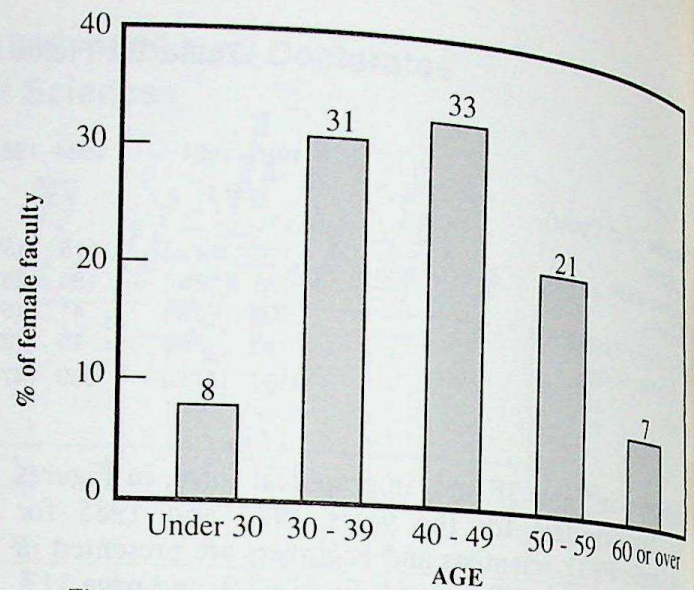


Figure 3. Age distribution of female mathematical sciences faculty, all groups.

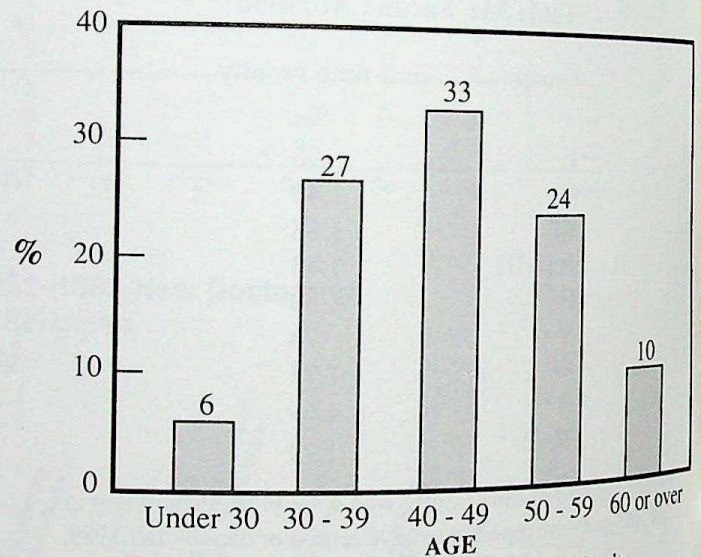


Figure 4. Age distribution of mathematical sciences faculty, Groups I, II, III.

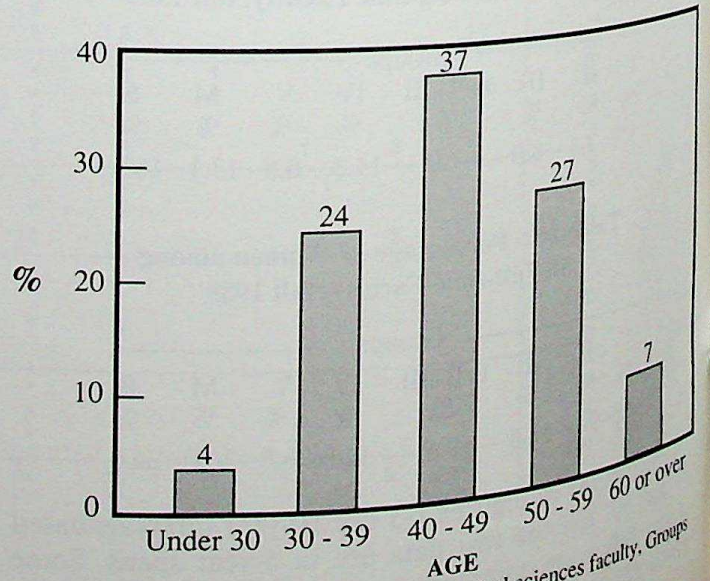


Figure 5. Age distribution of mathematical sciences faculty, Groups I, II, III.

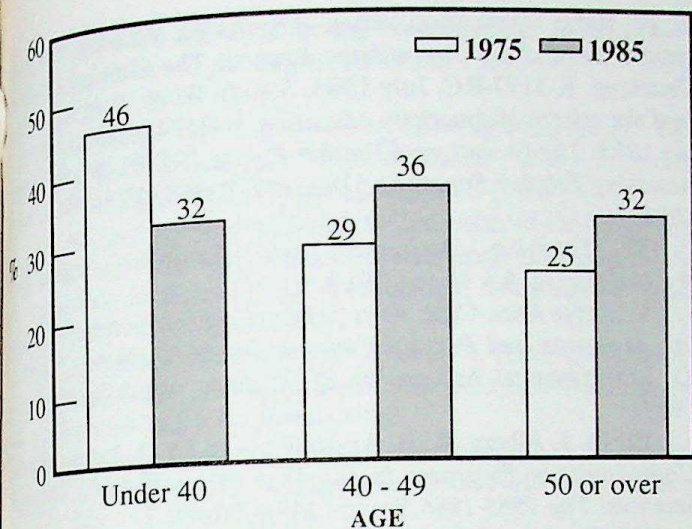


Figure 6. Age of Academic PhD Scientists and Engineers, 1975 and 1985. (Source: Commission on Professionals in Science and Technology Occasional Paper 89.3. Data Source: National Science Foundation)

IV. Undergraduate Enrollment Profile and Majors

The data in Table 4A are based on fall 1988 and fall 1989 enrollments reported on the 1989 Departmental Profile survey form, which requests two years' data on enrollments and departmental size. In particular, the comparisons in Table 4A are from the same set of respondents and do not use the results of last year's Annual Survey.

Table 4A: Percentage Change in Undergraduate Enrollments, fall 1988 to fall 1989

Groups				
I	II	III	M	B
-1%	-1%	0%	+3%	+3%

Table 4B: Undergraduate Enrollments Distribution, fall 1989

Group	Remedial Mathematics*	Remedial Mathematics + Pre-calculus	Remedial Mathematics + Pre-calculus + 1st-yr. Calculus
I	%	%	%
II	9	24	60
III	7	28	59
I+II+III	11	35	58
M	10	31	59
B	15	33	49
M+B	19	35	49
	17	34	49

*Arithmetic, high school algebra, geometry

Table 5: Percentage of Women among Junior/Senior Majors (including double majors), fall 1989

Groups							
I	II	III	I+II+III	IV	V	M	B
%	%	%	%	%	%	%	%
36	41	42	39	43	28	46	46

V. Graduate Enrollments in the Mathematical Sciences, Sex and Citizenship

The data in Table 6 are based on fall 1988 and fall 1989 enrollments reported on the 1989 Departmental Profile survey form, which requests two years' data on enrollments and departmental size. In particular, the comparisons in Table 6 are from the same set of respondents and do not use the results of last year's Annual Survey.

We report a large drop of 15% from fall 1988 to fall 1989 in first-year full-time graduate students in Group I, but a large increase of 21% in Group III. For Groups I, II and III combined the numbers of full-time graduate students increased by 3% for first-year students, and 4% for all years.

Table 6: Graduate Students
Percentage change, fall 1988 to fall 1989

	Groups				
	I	II	III	I+II+III	IV
	%	%	%	%	%
First year, full-time	-15	+8.4	+21	+3	-9
All years, full-time	-1	+8	+7	+4	+1

Table 7: Percentage of U.S. Citizen Women among U.S. Citizen Graduate Students, fall 1989

	Groups						
	I	II	III	I+II+III	IV	V	M
	%	%	%	%	%	%	%
First year, full-time	23	34	39	32	46	21	46
All years, full-time	22	30	36	29	46	20	45

Table 8: Citizenship of Graduate Students, fall 1989*

	Groups				
	I	II	III	IV	M
	%	%	%	%	%
First year, full-time	53	58	58	56	77
All years, full-time	50	53	59	47	74

*Percentage of U.S. citizens among graduate students whose citizenship is reported as known.

USEABLE RESPONSES

Survey	Groups							
	I	II	III	IV	V	VI	M	B
	%	%	%	%	%	%	%	%
Departmental Profile*	92	81	80	75	23	59	54	44
Faculty Age	64	84	87	69	32	69	57	43

* There are 4 parts to the Departmental Profile form (Enrollments, Majors, Departmental Size, and Graduate Students). The number given is the percentage of returns with a useable response on the departmental size.

Acknowledgement

The Annual AMS-MAA Survey attempts to provide an accurate appraisal and analysis of various aspects of the academic mathematical scene vital to the entire mathematical community. Yearly, collegiate departments in the United States, and the doctorate-granting departments in Canada, are provided the opportunity to respond. The quantity and quality of the responses directly determine the quality of the information in these reports. Without the dedicated cooperation of the secretarial and administrative support staff in the mathematical science departments we would not be able to conduct a survey, nor be confident in our analysis of its results. We are, unfortunately, unable to thank personally all the departmental assistants for their cooperation, but it is nonetheless appreciated. However, we are able to thank the administrative support staff of the AMS, especially Marcia Almeida, Monica Foulkes, and James W. Maxwell, whose efforts are acknowledged and appreciated.

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NOMINATIONS FOR THE 1991 SATTER PRIZE

In 1990, the American Mathematical Society established the Ruth Lyttle Satter Prize in Mathematics (see page 584 of the May/June 1990 issue of the *Notices*). The Satter Prize is to be awarded in odd-numbered years and will recognize an outstanding contribution to mathematics research by a woman in the previous five years. The first Satter Prize will be awarded at the Joint Mathematics Meetings in San Francisco in January, 1991.

The Committee to Select the Winner of the Satter Prize for 1991 (Joan Birman, Columbia University; Linda Keen, Herbert H. Lehman College of the City University of New York (chair); and Karen Uhlenbeck, University of Texas at Austin) is seeking nominations and suggestions from members of the mathematical community.

Nominations should include the candidate's name, affiliation, field of research, and a description of the work for which the prize would be awarded. This material should be sent to

Robert M. Fossum, Secretary of the AMS,

Department of Mathematics, University of Illinois, 1409 W. Green Street, Urbana, IL 61801

Nominations must be received by **September 30, 1990.**

Making Mathematics Work for Minorities

National Convocation Rallies Forces for Change

A booklet about the history of the National Academy of Sciences building in Washington, DC has on its cover a picture of the Academy members of 1925, standing in front of the building. One wouldn't necessarily notice that the group is all white and all male, because that's usually what scientists look like; in fact, the 1990 membership of the prestigious Academy is not much different in composition. But when the booklet was included among the materials for a convocation entitled "Making Mathematics Work for Minorities," held at the Academy in May, the photo elicited a few ironic smiles.

As the song goes, the times they are a-changing. The convocation, sponsored by the Academy's Mathematical Sciences Education Board (MSEB), reflected a sense of unity and urgency among the participants. With representatives from industry, government, and education from forty states, this active and motivated group said that change is needed not only to break the low expectation-low achievement cycle of minority students in mathematics, but also to forestall a workforce crisis in science and technology. The convocation capped a series of six regional workshops, which produced a 27-page list of recommendations for change.

The convocation had a distinctly different flavor from most meetings one might find at the Academy, partly because of the racial mix of the 500 participants, and partly because of the activities on the program. From the Native American prayer in the opening invocation, to the Native American dancing after the banquet that evening, to the inspiring "invocation in song" during the recognition luncheon the following day, the convocation successfully meshed the academic and the cultural.

Demographics Tell All

The sense of urgency at the convocation was fueled by the perception that increasing the representation of minorities in science and technology is no longer a question of justice and equity. Speaker after speaker emphasized that the nation must develop the mathematical and scientific talent of minority youth, because the traditional pool of white males is simply not large enough. "We need to get

away from the myth that this is an affirmative action issue," said Jaime Oaxaca, Vice-Chairman of Coronado Communications Corporation. "It's demographics."

According to a position paper by Shirley McBay, dean for student affairs at the Massachusetts Institute of Technology, minority Americans will fill 56% of all new jobs between 1986 and the year 2000. "These new workers will not only require better education in schools," she wrote, "but in college as well, for in the year 2000 half of all jobs will require some college, and 30% will require a Bachelor's degree." By the year 1996, she notes, there will be 45,000 fewer students with mathematics and science B.A.s than the nation will need to maintain its present economic status.

Connections to Social Ills

The urgency was also heightened by an acute awareness of the massive social problems connected to the educational issues. Poverty, drug abuse, violence in the schools, malnutrition, single-parent households, teen-age pregnancy, despair—such factors conspire to reduce educational opportunities for minorities. In her paper, McBay gave some sobering statistics: 15% of all black students and 36% of all Hispanic students drop out of high school; 50% of the 1987 high school graduates could not read well enough to master moderately complex tasks; and half of American 17-year-olds cannot handle junior high school-level mathematics problems.

Robert Chase, vice-president of the National Education Association, said he was somewhat disappointed that recommendations from the regional workshops did not mention such problems as poverty, drug abuse, and crime. The educational recommendations were sound and he did not expect a sociological treatise, he said, but minority achievement in mathematics is fundamentally tied to such issues as medical help, preschool education, and prenatal care. "School reform demands social reform," he stated simply. "You just can't have one without the other."

Robert M. Neilsen, assistant to the president for higher education of the American Federation of Teachers

(AFT), acknowledged the social problems, but said, "You can't wait to solve the big social issues. You've got to do what you can in the classrooms today, with the teachers and students you have." Neilsen, who has a Ph.D. in mathematics but left academia for the AFT some years ago, said that, at a school he visited in Texas, minority students were excelling in mathematics, as a result of changes in the curricula and the educational system. And in a neighboring town, he said, education reforms were actually leading social reforms. "There are hundreds of programs out there, and they all work," he said. "Don't wait for the perfect program. There are things you can do right now." Neilsen described these and other programs in "Anyone Can Learn Math: New Programs Show How," in the Spring 1990 issue of *American Educator*.

Attitude Change Needed

Many speakers declared that change in minority achievement will not come without a change in attitude, for the idea that minorities simply lack the ability to learn mathematics is still prevalent. For example, Neilsen's article prompted a letter from Julian Stanley, professor of psychology and head of the Study of Mathematically Precocious Youth at Johns Hopkins University. Calling the tone of the letter "sarcastic," Neilsen stated that "[Stanley] basically said these 'miracle programs' come and go, we've heard it all before, these programs don't withstand evaluation. The letter really knocked the programs and said it just isn't true that anyone can learn mathematics."

Another problem is that teachers often expect minority students to do poorly. Lacking the necessary motivation and self-esteem, these students fall into a cycle of failure and are sometimes blamed for their circumstances. Several speakers decried the use of "tracking," in which students are sorted according to ability. Often minority students are steered into the lower tracks, where instruction is poorer, expectations are lower, and opportunities for moving ahead are few. And several speakers noted that, despite desegregation, minority schools still lag in resources and trained teachers. "When 'white flight' occurred, they took their standards and their expectations with them," as one speaker put it.

Changes in curricula may help to address some of these problems. Mathematics must be taught in such a way as to relate to the lives of the students and to their cultural background, many speakers said. "People have to see themselves in what they do," said Charles Merideth, president of New York City Technical College of the City University of New York. He cautioned against "bastardizing" the subject (he joked about using a rap lyric in class: "The square root of 16 is 4/Hey, bro, close the door"), but saw a need to relate the subject to the students' lives, "to make mathematics breathe for them."

Anita McDonald, dean of the Evening College at the University of Missouri-St. Louis, pointed out the importance of shifting the emphasis of mathematics curricula. "We need to incorporate the achievements of African-Americans into the teaching of mathematics," she noted. "Mathematicians tend to think this is the task of mathematics educators, and they want to deal only with the 'pure' subject matter." Merideth suggested that, for example, discussing the mathematics of the Egyptians would help students to see that blacks are not "genetically incapable" of learning mathematics—a stereotype that some students have internalized.

The premise that all students can learn mathematics will require a restructuring of curricula to move away from rote learning and remediation, noted J. Arthur Jones, president of Futura Technologies, Inc. and chair of the steering committee for the Making Mathematics Work for Minorities project. Many speakers referred to the recent reports, "Everybody Counts," "Curriculum and Evaluation Standards for School Mathematics," and "Reshaping School Mathematics," all of which call for greater emphasis on applications and real-world problems, less rote learning and memorization, and a more student-centered approach to teaching. Some suggested that these reports could help in revising curricula in ways that would benefit all students, and minority students in particular.

Neilsen said that some minority schools have made curricular innovations that could be useful in other schools as well. He suggested that educational reform be centered at urban minority schools, where the need is the greatest. If those schools began to see improvements, the suburban schools would "scramble" to get their hands on the new curricula. The idea of starting in the suburban schools and allowing curricular reform to "trickle into" the urban schools would not work, in Neilsen's opinion.

Changes in Higher Education

Although the convocation emphasized precollege mathematics, there were specific suggestions for higher education. Uri Treisman, E. M. Lang Visiting Professor of Mathematics and Social Change at Swarthmore College, said that higher education has to get its own house in order and admit that "we've been an enormous failure." His statistics make a persuasive case. In 1988, out of about 100,000 non-Asian students of color in the California State University system, only eight received bachelor's degrees in science and mathematics. In a study of ten four-year liberal arts colleges, black students' calculus grades averaged 1.7 out of 4.0, and averages in the 1.0-1.5 range are common in public institutions. Mathematics departments have created a series of courses called "precalculus" that do not work, he said, noting that out of 422 students at U.C. Berkeley who

took precalculus, only one survived to get better than a C+ three years later in the calculus course designed for mathematics and science majors. "Data of that kind means nobody has looked seriously at this problem," he remarked. "It's unbelievable that no one has noticed the magnitude of our failure."

Mathematics departments need to evaluate who is making good use of mathematics courses and majors, he said. "Half a million students take calculus each year, a subject that by any standard is one of the great intellectual achievements of Western civilization," he declared. "It's a great subject, it drips with power. But how many students are impressed with it? How many say, 'Wow!'" And why are minority students especially prone to failure in such courses? Mathematics faculty members have to approach such problems with an empirical, investigative spirit, Treisman says. "It can no longer be a personal mission of an individual faculty member," he remarked. "It has to be a departmental mission."

The recommendations coming out of the regional workshops formed the basis of discussions during the convocation, which in turn resulted in an outline for a "Ten-Year Plan" for improving the mathematics achievement of minorities. According to Beverly Anderson, director of minority programs at MSEB and professor of mathematics at the University of the District of Columbia, the Ten-Year Plan contains recommendations for every sector and educational level. For example, the news media can inform the public of the urgency of the problem and counteract stereotypes that minorities cannot succeed in mathematics. Communities are called upon to develop local coalitions for mathematics education, and professional organizations are asked to disseminate recent mathematics education reports. The Plan also calls for improvements in teacher education and retraining. A report containing the Ten-Year Plan will be issued to the convocation participants.

Reactions of Participants

Participants seemed to find the convocation useful in drawing attention to the problem of underachievement of minority students. Gail S. Young, a professor of mathematics education at Teachers College, Columbia University, compared the convocation to the Calculus for a New Century conference, held at the National Academy in 1987. "That conference did start work on modifications of the present calculus course, but does not seem to me to have had much effect," he said. "This convocation has been much more exciting, more realistic. It might have a real impact." And compared to a meeting of mathematics faculty of traditionally black institutions in the South that he attended in 1970, the convocation participants were much less isolated, he said. "Here

people are much more informed, alert, and active. It's a real upward change for minorities in the mathematical community."

McDonald was encouraged that the convocation took place, "but I wonder how the goals will be interpreted and enacted by the various organizations," she said, referring to the Ten-Year Plan. But also, she said, "while we're waiting for this massive national movement to take place, we shouldn't forget that individuals can make a difference right now." James A. Donaldson, professor of mathematics at Howard University, says that he was somewhat disappointed with the Ten-Year Plan recommendations, which he felt neglected such important issues as building confidence and self-esteem, curricular content, and the way that subordinated groups are sometimes unintentionally discouraged. "I felt that they could have gone much farther with recommendations for the Ten-Year Plan," he said. "Still, it was very useful to meet with so many seriously committed people."

The convocation brightened prospects for change, but also seemed to point up some obstacles. Lee Lorch, professor of mathematics at York University in Canada, criticized the speeches by Lauro Cavazos, U.S. Secretary of Education, and John B. Taylor of the President's Council of Economic Advisers, the highest-ranking government officials in attendance. "The government representatives had diplomatic words indicating the worthiness of the objective, but absolutely no suggestions that the government is going to put its money where its mouth is," said Lorch.

However, the convocation succeeded in gaining the attention of a wide range of groups. "This was an excellent effort to create a focal point in which individuals and agencies can look at some of the causes of the problems and commit themselves to solutions on a specific timetable," said Johnny L. Houston, professor of mathematics at Elizabeth City State University and president of the National Association of Mathematicians. "The point is an organization of black mathematicians. 'The group may have to make this a national priority. This group may have done that. The jury is still out, but the effort has begun.'"

Minority achievement in mathematics is often cast in terms of a problem needing a solution rather than a possibility for success. "Listening to the data, it's easy to get discouraged," said Shirley Malcom, head of the Directorate for Education and Human Resources Programs of the American Association for the Advancement of Science. "I'm not a masochist. I would not have stayed in the work if there were no possibilities. Don't despair. I'm here because of the urgency of the problem, but also because of the possibilities."

Allyn Jackson
Staff Writer

Forum

The Forum section publishes short articles on issues which are of interest to the mathematical community. Articles should be between 1000 and 2500 words long. Readers are invited to submit articles for possible inclusion in Forum to:

Notices Forum Editor
American Mathematical Society
P.O. Box 6248
Providence, RI 02940

Small Research Grants

Jerome A. Goldstein
Tulane University

The issue of small research grants has been under discussion in the mathematical community in recent years. In particular, this has been a recent topic considered by the advisory committee of the Division of Mathematical Sciences (DMS) of the National Science Foundation (NSF), on which I have just completed a three year term.

The key background issue is that relatively few mathematicians have federal funds to support their research. The health of our entire mathematics profession depends on the health of our research enterprise, and it needs improved health. Here are some interesting figures. The number of mathematicians teaching students (full time) in four year colleges and universities is around 25,000. Of these around 10,000 are active in research and close to 2,000 have federal funds to support their research. Let us summarize this by saying that 7-10% of the mathematics professors are federally funded. (Here funding includes NSF, DOD, DOE, NIH, etc.) The corresponding percentages in chemistry and physics are estimated to be in the 40-50% and 50-60% ranges. So here is one criterion by which we, as a community, fare poorly.

Not surprisingly, most mathematicians would like to see more mathematicians involved in federally funded research. Indeed, this was one of the main priorities of the 1984 David Report, and it remains a principle priority of the forthcoming David II report, formally known as *Renewing U.S. Mathematics: A Plan for the*

1990s. (For the Executive Summary of David II, see the May/June issue of *Notices*, vol. 37, no. 5, pp. 542-546.)

One goal of the original David Report was to increase the number of funded researchers from 1800 to 2600, an increase of 800. (Think of a funded researcher as a (maybe co-) principal investigator on a grant providing summer salary support. Again, this 1800 includes those funded by NSF, DOD, etc.) By now the 1800 has increased to 1900, so David II recommends an additional 700.

Of course we have seen a big increase in postdoctoral fellowships, graduate student support, institute support, and conference support. But mathematicians tend to think of mathematics as an individual endeavor and the support of the research of individuals remains a high priority.

Available funds are limited, and if it is not possible to fund deserving scholars with "big" grants then the discussion of "smaller" grants inevitably follows.

If we can get the additional 700 grants recommended by David II plus 500 more grants, then we have 3100 funded researchers, a significant increase from 1900. (But our percentage moves up to 11-14%, still far below chemistry and physics. Incidentally this discussion illustrates why many thought the original David Report understated the problem.)

Several reasons have been offered both in support of and in opposition to small grants. Here is a sampling of each.

Arguments in support. It is the grant, not the size of it, that brings the recipient satisfaction, recognition, and inspiration. It applies pressure to the individual to do research and publish it. More successful grantees could serve as role models for attracting students into the profession. The Canadian system works well. A significantly higher percentage of deserving active researchers could be funded.

Arguments in opposition. A substantial grant brings a significant amount of leveraged, dedicated time. The scholar is forced to do research, there is no excuse for failing to make it one's top priority. A small grant is not nearly as effective in this respect. A large number of

small grants is a hard and unwieldy thing to administer. Reviewers already complain about being overworked. The paper work is enormous. Some believe there are not 3,000 mathematicians in America whose research is worthy of support by our tax dollars.

The Association for Women in Mathematics (AWM) has an NSF grant for (small) travel grants for female mathematicians. This is widely regarded as a very successful program.

I next wish to describe a particular model discussed at the recent DMS Advisory Committee meeting in April 1990. The reader should regard this model as a "trial balloon". The American Mathematical Society (AMS) will be mentioned, but the ideas discussed in the sequel are preliminary and not officially endorsed (either positively or negatively) by the AMS. So here, finally, is the idea.

"AMS Research Grants" are created, with 500 being given each year with an average funding level of \$2500 per year. These might range from \$1000 to \$5000, depending on the nature of the proposal, but the canonical grant would be for \$2500. This would be administered by the AMS through *some* mechanism, undoubtedly involving panel review. NSF and other federal agencies would fund it for the first five years. The AMS would try to build up an endowment to continue its role as a research funder. The federal support for this program would be temporary (under the possibly unrealistic assumption that the AMS can generate the requisite endowment). Maybe the federal funding agencies would like this idea so much (especially the temporary aspect of their funding) that they would find new funds for this program. (This too may be an unrealistic assumption).

The DMS Advisory Committee generally favored this idea.

It is a widely held view that the David Report was marvelous and effective. It dramatized our problems and it led to real progress in the funding of mathematics (more money, more postdocs, more graduate student support, etc.) But it understated the problem and some of its important recommendations have not yet been implemented. Much more needs to be done. It will be difficult to find the money to fund the additional 700 researchers recommended by the David II report. And even then, with 2600 funded, many talented and active research mathematicians will still be untouched by national funding.

Up to this point I have tried to avoid my biases and present a balanced picture of the small grant situation. Here, for the record, are my own views:

It is my personal feeling that if there exists a fixed amount of money to spend on research, the profession derives more benefit from a lot of small grants rather than from a modest number of substantial grants. (I leave aside the fact that the nature of our grants may

well affect the size of the available pot).

A standard summer grant buys two things: the dedicated time and the good will of the investigator. By the time a senior mathematician (who is a committed researcher) is making a good salary, conscience and competitive nature will dictate that her/his summer time be spent on research, whether or not it is funded. Currently there is a salary cap of about \$8,000 per month, which affects those with an academic year salary of over \$72,000. Perhaps 20% of the DMS principal investigators fall into this category. It is not clear to me that an NSF grant is really buying the time of these researchers.

It bothers me that, in my own department, only a minority of the deserving (in my opinion) researchers have external research funding.

When the academic job market turned sour in the 1970s, many qualified researchers took jobs in schools without research traditions. We thus created a national resource ("good mathematics almost everywhere") which we can but have failed to exploit. These schools train many of our future research mathematicians. They would train more if the qualified professors who should inspire these students can remain active and enthusiastic over an extended period of time. Small grants would help these professors and their institutions. Since generally the better scholars are at the better institutions, and since the awarding of grants must be made on a comparative quality level, the only way to support effectively the researchers under discussion is to increase substantially the number of grantees.

The NSF funding of conferences touches a lot of graduate students and young researchers who do not have other research support. The enthusiasm that these youngsters (and oldsters too) express and their resulting renewed commitment to the study of mathematics persuades me that it is a marvelous idea to maximize the number of researchers touched by federal funds.

I would like to make one final personal observation. It has been a privilege and an extraordinary experience for me to have served on the DMS Advisory Committee. The staff at NSF is fantastic. They have patiently listened to all the complaints expressed by me and my colleagues. They have generously shared their thoughts with us. They are displaying total frankness and compassion. They are incredibly hard working and devoted to the welfare of the American mathematical community. Some may bitch and moan that we are not where we should be with respect to funding in mathematics, but we are in much better shape than we would be otherwise because of the heroic efforts of Judy Sunley, Bernie McDonald, Jack Ryff, Ralph Krause, Ann Boyle, Al Thaler, and all the others at DMS. Our community owes them our deepest expression of thanks (and our most serious urging to keep up the good work and to do even better in the future).

We must keep our talented research corps active and motivated with high morale. We must attract good students into mathematics, in greater numbers. These are the issues before us. It is really important that the community get involved. Discuss these matters with your colleagues. Write to Judy Sunley and others at the DMS of NSF; write to Bus Jaco and others at the AMS; write to the DMS Advisory Committee's new chair, Mary Wheeler, and its other members. Please involve yourself. The health of our whole mathematics community depends on the health of the research enterprise.

More on Researchers and Education

Hugo Rossi

University of Utah

I read with interest and enthusiasm the articles in the first FORUM (*Notices*, April 1990). The question, *What is the role of mathematical researchers in mathematical educational reform?* is now being asked at all major conferences and meetings, inspired, I suppose, by the insistence of the leadership of the National Science Foundation (NSF) some years ago that there just has to be some such role. Election to the Council last year drew me from the relative peace of science in Utah and dropped me in the AMS' Committee on Long Range Planning which is now asking me the same question. As I must now answer it, I choose to do so with a contribution to the FORUM.

There is a role for research in education reform. Drs. Herb Clemens and Harvey Keynes are right; but I disagree with them. Herb's plan for direct involvement of research mathematicians in grade school education is a credible and creditable one. Where this was done with imagination, ingenuity and patience (and Herb excels with all three) it has been exceedingly successful. And it is best to get to them in grade school before *their interest and excitement yields to other compelling influences*. However, I do not believe that the central issue is the preservation of the species. Harvey argues, and (as a Dean) I support him, that attitudes must change: *professional tolerance for colleagues who want to become involved in education should be encouraged at all levels*. But I find fault with what he says later: *It is frequently not the conception of the project, but the enormous organizational and administrative efforts, together with sensitivity to classroom cultures in the context of mathematics content, that makes for successful educational programs*. While I agree with him, I do not see this as the business of the research mathematician who might best be left out of those efforts.

What then is the central issue, and how can the research mathematician be useful in addressing it? Before giving you my response, let me confess that I have been

unfair to the writers of April's FORUM articles. For the purpose of my own axe-grinding, I have attributed to them interpretations of their writing to which I know they do not ascribe. Dr. Clemens is not saying that cultivation of future mathematicians is the central issue of educational reform; he is saying that it is an issue, and the one to which research active mathematicians can address themselves without compromising that activity. Dr. Keynes is not saying that research mathematicians should applaud, support, and even become, those among us who are prone to meddle around in education as if we knew better. Through his own work, Dr. Keynes has amply demonstrated his very clear conception of the role of the researcher in educational reform, and he makes us understand that the projects to which he refers require the combined effort of educators and professionals at all levels, each playing their appropriate role. What then is that role of the researcher in education, and how is it to be implemented, and in what ways can the AMS be involved?

The central feature of research is that the worker must live, intellectually, in a highly ambiguous environment. Problems are not really well formulated, the data is either insufficient, buried in irrelevancies, or both, approaches are obscured, and outcomes, although guessed at, are highly uncertain. To put it bluntly, most of the time we feel stupid. The issue in education for the researcher is that the purpose of our educational system seems to be to drive out, at the earliest age possible, any ability to tolerate the feeling of stupidity. This is an observed phenomenon: men and women entering college do not display the same eager inquisitiveness, curiosity and tolerance of their own intellectual innocence which is displayed by boys and girls entering first grade. It is not my purpose to go into the causes of this although I believe that the intellectual standards of our culture play a significant role.

Why don't girls and minorities do as well in mathematics as white boys? First of all, although this is a popular question, the assumption underlying it is mistaken. The correct observation is that girls and minorities do as well as boys at the same educational level, but drop out of the math/science curriculum at markedly higher rates. Why? Because being unsure of yourself doesn't look good. The difference between underrepresented and overrepresented groups is that of acceptance; if you are a member of the majority, it is automatic; if not, it has to be achieved. These are obvious but not trivial statements. The discomfort of intellectual uncertainty is very difficult to tolerate, all the more if you are on the outside looking in. If you are accepted, it's not so bad to take risks; recovery (often by bluff) comes easy. If you are aspiring for acceptance, risks and displays of uncertainty and weakness are to be avoided, and attempts at bluff are disastrous.

What is the role of the researcher in education? To turn things around; insist that it's not only OK to live with uncertainties, but that it is essential to progress. Insist that having to work in ambiguous situations is not restricted to research mathematics, or the academic environment, but is a reality throughout the professions and today's workplace wherever it is. Instruct that there is more value in the thrill of the hunt than the size of the trophy; help create endless illustrations of this at all educational levels, and above all, crusade to get this program adopted. (We have had several years now of pilot and model educational projects, some of which are exceptional. There is less need today for pilots than there is for stewards).

How is the role played out? Clemens and Keynes have two excellent and important ideas: 1) stop being so smart, go out and be stupid for the kids, show them what it is about scientific research that attracts you; 2) struggle to change our academic culture so that not only do we notice that there are students around, but we know how to shepherd them through intellectual challenges. These ideas are important, not only because they address the problems directly, but because they address the culture; they make a statement.

As I have unfairly paraphrased the content of other articles, I have unfairly represented my own thesis. I can do a better job of expressing my ideas only by citing examples which illustrate them in operation. (First suggestion: let that last sentence be our guide in teaching).

Phil Wagreich, University of Illinois at Chicago, and coworkers have developed a sequence of "experiments" (basically elementary qualitative physics) for primary school children. They have worked directly with the teachers, using illustrative experiments at their level as well, so that the teachers themselves get to experience the thrill of uncertainty before introducing it into the grade school environment. This program has had remarkable success with the disadvantaged student in the Chicago area. Here, in the state of Utah, some of us are hoping to move part of the grade school curriculum away from workbooks by similar techniques. We have begun to train "teacher-leaders" for the school who can instruct their colleagues in experimentation and provide tools for it. I am teaching calculus to a small group as part of this program. No, I'm *not* teaching calculus; I am showing them how to analyze data graphically, that dynamical processes are understood by formulating the rules of change, how to test hypotheses by means of specific data and spreadsheet manipulations. Last week we worked on inhibited growth, and by studying the US census from 1790 deduced that the US population looks like it will

stabilize toward the end of the next century at around 299 million.

The NSF programs, *Young Scholars* and *Research Experiences for Undergraduates*, are superb programs from this point of view. Although they are motivated by preservation of the species and directed toward the most promising young scholars, they have profound effects in other ways.

First of all, we the researchers are introduced to the idea that there is something to the way we do our work which must be, and *can be*, communicated at all educational levels. Secondly, these students become conduits of scientific method to their colleagues. In effect then, although it doesn't say so in the NSF announcements, these programs are direct attacks on the national culture.

What is the role of the AMS in mathematics education? If I am right, that the role of the researcher is to insure by illustration that the technique and ideas of the process infect the entire educational enterprise, then the role of the AMS is clear: it must explain to the schools, the public, the government and, above all, *its own members* what mathematics research is doing, how and why. It must do so in its own meetings, its publications, and through its interaction with other societies. We need expository journals, conferences and panel discussions. Above all, our research leaders need to feel in their joints and eyesockets the absolute necessity of explaining to that world out there, the one we live in, what they are doing. The age of the mathematician who declares, "I do what I do because I do it" is over.

Do I have a good idea? Will it work? Do they do it in Japan and Korea? I don't know the answers to the first two questions, but the answer to the last is: *No*. What they do in Japan and Korea is endless workbooks, drill and exercise. They do require everybody to take a lot more mathematics, but their technique is about the same as ours; their classes are as full, and their texts as dull. Well then, why should we do something different? Because what we (and they) are doing isn't working here. The Japanese culture (as well as the Jewish, Chinese and other cultures which produce disproportionately large percentages of research scientists) has a deep respect for inquisitiveness, contemplation and intellectual probing; it is built into their religion, their society and their education. We have no such asset, and we're not going to get it by paying for it or proclaiming an education Presidency. All we can do is give the kids a viable alternative to the press of instant gratification prevalent in our culture, and let them run with it.

Inside the AMS

Committee for Academic Review

J. K. Goldhaber, Chair

The Committee's charge was to consider two topics: guidelines for the use of mathematics visiting committees and the question of accreditation of mathematics departments by AMS. The Committee's immediate, unanimous, and emphatic response to the question of accreditation is that the AMS should not be involved. Our general response to the first topic, however, is that the AMS should serve, but not dictate.

Developing guidelines for mathematics visiting committees involves two tasks: compiling a list of external visitors and suggesting topics for consideration by the reviewing committees. We feel that the AMS should not appoint external visiting committees. We do recommend that, in response to many requests, the AMS should maintain and regularly make available a list of individuals who are willing to serve as visitors, cross-referenced by geographical area and area of interest. One possible procedure for developing such a list would be to invite those who are interested to submit their names.

Topics for possible consideration by review teams will be drawn up by this committee and will include specific questions that address the quality of the program and the consonance of a department's stated mission with the department's actual performance. Some obvious items for consideration are appropriateness and quality of undergraduate and graduate curricula; the quality of the department's Ph.D. output; the average length of time to degrees; the structures for determination and reward of faculty merit; etc. We may also identify specific input and output measures that can be used to address these questions. From the list of possible areas of focus, the department to be reviewed could ask the external review team to pay particular attention to a subset of these items.

We are looking at the activities of professional societies of other academic disciplines to see what programs they have in place concerning external review committees.

The Mathematical Association of America's (MAA) Committee on Consultants has also tackled this topic and has in fact published a "Program of Consultants: 1990 Information Booklet." There is a general feeling that, to avoid duplication of time and effort, this committee should work together with the MAA committee to provide this service and that both committees should be coalesced into a single MAA/AMS committee.

Comments and suggestions on procedures for developing a list, on appropriate topics for consideration in a review, and on the joining of the two committees are solicited and would be most welcome. Please send your comments to any of the committee members listed below.

F. W. Gehring, University of Michigan
F. L. Gilfeather, University of New Mexico
A. M. Gleason, Harvard University
J. K. Goldhaber, Chair
D. A. Sanchez, Mathematical and Physical Sciences
Directorate, National Science Foundation

Committee on Human Rights of Mathematicians

Alice T. Schafer, Chair

In the past two plus years the Committee has considered seven cases of human rights violations of mathematicians or teachers of mathematics from six different countries: Canada, Chile, Malaysia, Palestine (West Bank), Somalia and Tunisia. In addition, at the AMS Centennial Meeting, August 1988, and at the Joint Mathematics Meetings in Phoenix, January 1989, the Committee circulated petitions on behalf of Russian mathematicians who wished to emigrate but had not been allowed to do so: nine at the first meeting and 14 at the second. At the Phoenix meetings petitions were circulated on behalf of two individual mathematicians.

The situation has improved so much in Russia that of the 14 individuals named in the petition of 1989, 12

have been allowed to emigrate. One individual on whose behalf a petition circulated has been released from prison and allowed to return to his position. The person named in the other petition has been released from prison and has a job offer at a university in the United States but, because his passport has not been returned to him, he has been unable to leave his country to accept the position. There is hope that his passport will soon be returned to him.

A current case of concern to the Committee is that of a mathematician who was imprisoned because of his criticism of his country's government. He was tortured while in prison, his passport was taken from him, his university salary was stopped, which left his wife and children without an income, and he was never tried. He was finally released from prison but not allowed to return to his position, nor was his salary reinstated. The government made two offers which he refused: one a position at a less prestigious institution at some distance from his home; the other permission to accept a temporary position in another country without promise that he can return to his previous position on his return to the country. Recently he wrote an article for a newspaper in which he was critical of the government but not recommending any violence. Again he was imprisoned. He has now been tried and has just received a two year prison sentence, which he is appealing. So, as far as the American Embassy in his country knows, he is not being tortured.

The case above, described in some detail, contains many of the features found in others cases: individual, not urging any violence, imprisoned, often without any charge, kept in prison and released only when the legal time for holding a person prisoner without a charge expires (true in the above case) - not all countries have such a law - tortured while in prison, passport withdrawn, family left with no income. In all cases the Committee has sent letters and sometimes cablegrams to the appropriate government authorities asking for information and urging leniency. In the past two years, two members of the Committee have personally investigated cases while they

were visiting a country where the Committee was working on particular cases.

The Committee investigated the case of the Chilean mathematics student Christian Meneses Torres who was arrested on April 10, 1985 by the Chilean police. (See the Report by the Chair of this Committee, C. Herbert Clemens, in *Notices*, August 1987.) According to the U.S. Department of State, which obtained information from our Embassy in Santiago, he was arrested for violating the arms control law, released on bond July 9, 1987, and "his case may be resolved in the near future".

The following groups have been very helpful to the Committee in its work by providing information in some individual cases: Committee of Concerned Scientists (New York), the Human Rights Committees of the American Association for the Advancement of Science (AAAS) and the National Academy of Sciences, and the Chicago Action for Soviet Jewry.

Sponsored Membership Program

Last year, the American Mathematical Society initiated a program of sponsored membership. Under this program, individuals and organizations may "sponsor" eligible mathematicians for membership in the Society by paying their membership dues. The program enables individuals who may not otherwise be able to pay the dues to be members of the Society. Therefore, eligibility for sponsorship is limited to individuals residing in countries with currency restrictions or in developing countries. The individual being sponsored need not be a current member of the Society. The dues rate to be paid for the sponsored member will be one-half the higher ordinary dues rate. For 1990 the sponsored member dues rate will be \$46; for 1991 it will be \$50.

If you know an individual whose membership you would like to sponsor or if you would like to learn more about the program, please contact Carol-Ann Blackwood, Membership Manager, American Mathematical Society, P.O. Box 6248, Providence, RI 02940 or via e-mail to AMSMEM@MATH.AMS.COM.

Washington Outlook

This month's column is written by Kathleen Holmay, who is the Public Information Director of the Joint Policy Board for Mathematics.

During the last weekend in April, I took a two-day hiking trip outside the Washington area and literally brought the message of Mathematics Awareness Week, Communicating Mathematics, with me. During the first day on the Appalachian trail, I wore a T-shirt celebrating MATHCONN '90, an annual event organized by Dr. Regina Brunner at Cedar Crest College that is designed to encourage women to pursue mathematics. During the second day, I elicited a couple of curious looks from other tourists in rural Pennsylvania because I was sporting a T-shirt with an eerie sleuth on the front which said "Mathematics Murder Mystery - Worcester Polytechnic Institute" on the back.

These were just two of the "gifts" I received from Mathematics Awareness Week 1990. Others were largely reports on a host of activities which were carried out in classrooms and other locations across the country - from a juggling explanation demonstration at Derby High School in Wichita to a poster contest for Washington, DC, area high school students sponsored by George Washington University. Clearly, a great many activities to "Communicate Mathematics" occurred during April.

By mid-May, the staff of the Joint Policy Board for Mathematics (JPBM) Office of Governmental and Public Affairs had dealt with over 300 requests for posters, postcards, and general advice. Moreover, Mathematics Awareness Week was the subject of an editorial in *The Washington Post*. While the writer saw the celebration as a "publicity gimmick", the editorial did recognize the importance of communicating mathematics and did acknowledge the "problems faced by math educators."

What may be even more noteworthy is that such activities in mathematics are by no means confined to one month any longer. In March, I had the pleasure of attending a symposium, "Modern Perspectives of Mathematics: Mathematics as a Consumer Good," sponsored

by the Mathematical Sciences Institute (MSI) at Cornell. It was clear to all who attended this meeting that the bridge spanning research interests and teaching needs was not only in place but being crossed repeatedly in a manner that allowed mathematicians on both sides to appreciate and understand each other.

Calvin C. Moore, associate vice president for academic affairs at the University of California and a member of the Mathematical Sciences Educational Board, talked about the general lack of appreciation of the role mathematics plays in all of science and technology. He warned the attendees of the danger of continued acceptance of the lack of interest in the field by most minority students. Moore informed his audience that white males comprise only 15 percent of this year's freshman class at Berkeley. He reiterated this figure to a stunned audience adding, "I said 15 percent, not 50."

Opening a compelling talk about "Communicating Mathematics," Ivars Peterson of *Science News* said, "To most outsiders, modern mathematics represents unknown territory; its borders protected by dense thickets of technical terms; its landscapes strewn with indecipherable equations and impenetrable concepts. Few realize that the world of modern mathematics is rich with vivid images and provocative ideas."

Peterson asked the audience: Where can an outsider go (to learn about mathematics)? He said that, "People seem genuinely interested in what goes on in mathematics, if the material is presented in a way that is meaningful to them," but acknowledged that there are few such avenues for the layperson today.

"My experience as a journalist reporting on mathematical research," he said, "has considerably broadened my view of mathematics. What I have come to appreciate is how much the understanding of mathematics requires hard, concentrated work. It combines the learning of a new language and the rigor of logical thinking, with little room for error."

Two reporters who were fairly new to mathematics attended this symposium through a special arrangement the JPBM was pleased to make with MSI. Clearly, their work was cut out for them, and I had the pleasure

of watching these two adept communicators work. I observed as they absorbed and deciphered the messages of the meeting and then asked questions which allowed them to ferret out a "story" from it for a lay reader. Several results were: a front-page story in the *Oakland Tribune*, calls to my office for more information on the problems of human resources in mathematics, requests regarding the "pipeline", etc.

Simultaneously, the JPBM Public Information Office makes many other media contacts on a daily and weekly basis. NBC-TV, for example, has been talking with us over the last two months regarding a program they are doing on the differences in achievement between girls and boys, focusing on the U.S.A. Mathematical Olympiad. This is a topic that immediately makes a television producer think of mathematics. For us, NBC's interest is an opportunity as well as a challenge. The opportunity, of course, is to get nationwide coverage for mathematics - if we survive the rigorous television editing process. The challenge is to portray mathematics as a field in which girls can and do excel - notwithstanding the statistical evidence that few of them do well in competitions and that too few choose the discipline. We have collected and forwarded a number of items to NBC - information on the performance of girls and boys in mathematics competitions, information about women who have succeeded in mathematics, etc. Yet, we can only hope to shape the story, not write it.

There is ample evidence that mathematics has become a viable subject of potential interest to the public. The challenge for us is to determine where to go from here. We need to carefully focus our efforts so that we maximize our resources.

What needs to be done in the short term is apparent. First, there is an opportunity to introduce Chicago area science writers to the speakers and their topics, espe-

cially new ones like Karmarkar's interior-point methods for linear programming, during the Society for Industrial and Applied Mathematics' summer meeting in July. Then, the Mathematical Association of America's (MAA) 75th Anniversary is the focus of the 1990 summer Joint Mathematics Meetings in Columbus. Juggling and mathematical sculpture are two obvious stories which may interest general reporters. Yet, they represent only a small fraction of what happens at such a meeting.

In the longer term, three priorities stand out. First, the JPBM Public Information Office continues to explore ways to generate and place a regular column on mathematics in newspapers across the country.

The second is that 1992 is both International Space Year and the anniversary of Columbus' first voyage to this continent. Both of these events are potential windfalls for communicating mathematics. We would like to assemble and distribute to reporters an information kit with many short summaries describing such topics as how Columbus navigated across the Atlantic and how mathematics is used in studying global climate change.

The third longer-term priority dovetails with the second. How can we establish an active network of mathematical expositors at several key institutions across the country who would be willing and able, through special arrangements with their departments, to work with us to produce explanatory materials for the media? The objects are to multiply the efforts of the JPBM Public Information Office without adding more staff in Washington and to display the expository talents of mathematicians who are located throughout the nation.

If you would like to volunteer for this exciting project, please contact me: Kathleen Holmay, JPBM Public Information Director, 1529 Eighteenth Street, Washington, DC 20036.

ALGEBRAIC TOPOLOGY

Mark Mahowald and Stewart Priddy
(Contemporary Mathematics, Volume 96)

This book will provide readers with an overview of some of the major developments in current research in algebraic topology. Representing some of the leading researchers in the field, the book contains the proceedings of the International Conference on Algebraic Topology, held at Northwestern University in March, 1988. Several of the lectures at the conference were expository and will therefore appeal to topologists in a broad range of areas.

The primary emphasis of the book is on homotopy theory and its applications. The topics covered include elliptic cohomology, stable and unstable homotopy theory, classifying spaces, and equivariant homotopy and cohomology. Geometric topics—such as knot theory, divisors and configurations on surfaces, foliations, and Siegel spaces—are also discussed. Researchers wishing to follow current trends in algebraic topology will find this book a valuable resource.

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News and Announcements

Lamberto Cesari 1910-1990

Lamberto Cesari, professor emeritus of mathematics at the University of Michigan, died March 12, 1990 at the age of 79. Cesari was known worldwide for his research in a variety of areas, including differential equations and optimal control.

Cesari was born on September 23, 1910 in Bologna, Italy. He studied at the prestigious Scuola Normale Superiore in Pisa and received his Ph.D. in 1933 from the University of Pisa. His first position was at the Institute for Numerical Analysis of the National Research Council in Rome. In 1935, he became an instructor at the University of Rome and returned in 1938 to the University of Pisa as an assistant professor. He moved to the University of Bologna in 1942 and became a full professor there in 1947.

Two years later, Cesari came to the U.S. and spent a year at the Institute for Advanced Study in Princeton. Over the next four years, he held visiting positions at the University of California at Berkeley, the University of Wisconsin, and Purdue University. He stayed at Purdue until 1960, when he moved to the University of Michigan. At Michigan, he was named the first Raymond L. Wilder Distinguished Professor of Mathematics and also held the position of Henry Russel Lecturer, the highest title bestowed on senior faculty at the University. He retired in 1980.

Cesari was awarded the degree

laurea honoris causa by the University of Perugia in 1978 and was elected to the Accademia dei Lincei in 1982. He was a corresponding member of the Academies of Science of Bologna, Modena, and Milan. A member of the AMS, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics, he also belonged to several Italian mathematical societies.

During his long career, Cesari served on several editorial boards and wrote four books and over 220 papers. He did some early work in the theory of surface area, on multi-dimensional functions of bounded variation and Serrin-type functionals. One of Cesari's abiding interests was the study of problems in the calculus of variations, and he also did a great deal of work in optimal control. Particularly noted for his study of the existence theorems for optimal solutions for both single- and multi-dimensional systems, he also contributed to the theory of necessary conditions and the analysis of Pareto problems. A significant portion of his contributions to this area may be found in his last book, *Optimization: Theory and applications*, published in 1983.

In the last twenty years, much of his attention was devoted to the study of questions arising in nonlinear analysis and its applications to differential equations. He continued his work, begun in the 1950s, on the Alternative Method, especially as applied to problems with large

nonlinearities. He also investigated the existence of solutions to certain quasi-linear hyperbolic systems. In recent years, he continued his study of existence theorems, analyzing various problems, including those which arise in the theory of plasticity and whose optimal trajectories may contain jump discontinuities. During the last few years of his life, Cesari worked on the theory of functions of bounded variation, a field that he himself had pioneered, and its applications to the theory of hyperbolic systems of conservation laws.

Dmitrii Konstantinovich Faddeev 1906-1989

Dmitrii Konstantinovich Faddeev, an outstanding Soviet mathematician and President of the Leningrad Mathematical Society, died on October 20, 1989 at the age of 83.

Faddeev's mathematical legacy is unusually diverse. His primary area was algebra, but he also made significant contributions to other areas, such as number theory, function theory, geometry, and probability theory. Faddeev had a profound influence on the formation and development of numerical methods in mathematics, and the book, *Numerical methods in linear algebra*, which he wrote with V. N. Faddeeva, has been a reference source for several generations of specialists. A keeper of the tradition of the Petersburg school of mathematics, Faddeev was a laureate of the State Prize of the U.S.S.R., and a corresponding member of the Soviet Academy of Sciences.

In addition to a publication list of more than 160 titles, Faddeev's career was marked by his interest in education. He was known for his many students, his contributions to the structuring of contemporary mathematical education, his creation of internationally-known scientific schools, and his outstanding textbooks.

Edgar R. Lorch 1907-1990

Edgar Raymond Lorch, a major figure in the algebraization of analysis and its recasting in geometrical language, died on March 5, 1990. He had been on the faculty of Columbia University for many years.

Lorch was born in Nyon, Switzerland on July 22, 1907, and came to the U.S. in 1917. He earned his A.B. in 1928 from Columbia College, and his Ph.D. in 1933 from Columbia University, under the direction of J. F. Ritt. In that same year, he was awarded a National Research Council Fellowship to work with M. H. Stone. The following year, he declined the position of assistant to John von Neumann at the Institute for Advanced Study to accept the Cutting Traveling Fellowship in Hungary to study in Szeged with Frigyes Riesz. Lorch in turn provided guidance to a succession of budding mathematicians during his long career at Columbia.

He began his long teaching career at Columbia University in 1935, serving as chair of the department from 1968 to 1972. In 1977, he retired as Adrain Professor Emeritus, and had also held the position of Chairman of the University Seminar on Computers, Man, and Society since 1982. He was a research mathematician in 1944 at the National Defense Research Council and served in 1948 as Scientific Advisor to the Chief of Staff of the U.S. Army at the Pentagon. In addition, he held professorships and lectured throughout the U.S. and Canada.

Lorch's most enduring mathematical contribution was perhaps in the theory of Banach spaces and spectral theory of operators in Hilbert space, which were quite new at the time he was working on them. In these theories, which are now standard equipment in pure and applied mathematics, problems of classical analysis can be reformulated in ways that permit the use of algebraic computation and geometric intuition in their solution. In addition to over 100 articles in a wide range of mathematical areas, Lorch's publications include *Spectral Theory* (the classic reference in the field), *Analysis Functional*, and *Precalculus*.

Throughout his career, Lorch was especially interested in developing international ties among mathematicians. Able to lecture fluently in five languages, he pursued many international activities, such as serving as a Senior Fulbright Lecturer in Italy, France, and Colombia; holding a corresponding membership in the Accademia dei Lincei of Italy; contributing to the founding of the Mathematics Department of the Middle East Technical University in Ankara, Turkey; and establishing a course in functional analysis at the Universidad de los Andes in Colombia. In addition, he was also a frequent guest of the Zürcher Gespräche in Zurich and Dusseldorf.

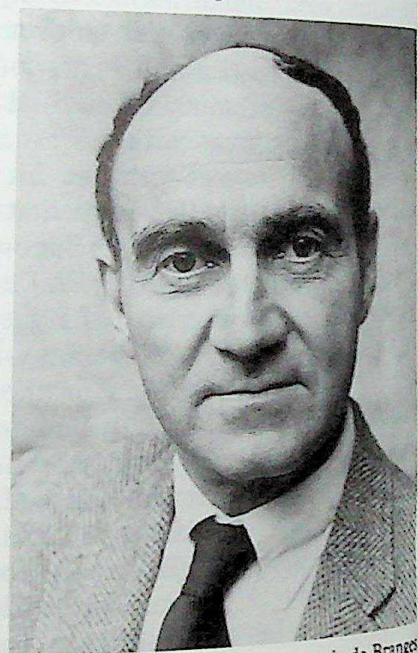
He was also an active member of the AMS, serving on various committees and as a teller in AMS elections (1937-1943), Member-at-Large of the Council (1952-1954), and Associate Editor of the *Bulletin* (1945-1950). He delivered an AMS Invited Address on the structure of normed abelian rings in 1944. He was also a member of the Mathematical Association of America and several foreign mathematical societies.

Together with his wife, Lorch founded in 1980 the Center for International Scholarly Exchange at Barnard College, in which he remained active until his death. In 1989, he was honored by the Uni-

versity of Szeged in Hungary for his work with Riesz. Lorch also had a deep interest in international education, as well as in environmental concerns. In addition, he was an accomplished pianist, organist, and composer.

de Branges Receives Ostrowski Prize

Louis de Branges of Purdue University has received the first Ostrowski Prize for developing powerful Hilbert space methods which led him to a surprising proof of the Bieberbach Conjecture on power series for conformal mappings.



Louis de Branges

de Branges was born in Paris in 1932, but he grew up in the U.S. After receiving his Ph.D. in 1957 from Cornell University, he began investigating the question of whether every bounded linear operator on Hilbert space has a non-trivial invariant subspace, and also worked on the Riemann hypothesis. However, his greatest accomplishment was the 1984 proof of the Bieberbach Conjecture, which surprised a mathematical world accustomed to small steps forward. In addition to that proof, he obtained certain more general results concerning conformal maps. His Hilbert space theory has contributed substantially to the un-

understanding of these and other problems.

The Ostrowski Prize of 50,000 Swiss francs was bestowed on de Branges on May 4, 1990 at the Mathematical Institute of the University of Basel. Jacob Korevaar of the University of Amsterdam, who was a member of the selection jury, presented the prize. The jury was headed by Norbert A'Campo of the University of Basel.

Alexander M. Ostrowski (1893-1986), who was a professor of mathematics at the University of Basel, established a Foundation for the Awarding of an International Prize for Higher Mathematics. The Ostrowski Prize is to be conferred every two years to a scientist or group of scientists who have achieved outstanding mathematical accomplishments, independently of politics, race, religion, domicile, nationality, or age. The jury consists of representatives of the Universities or Academies of Basel, Jerusalem, Waterloo (Canada), Copenhagen, and Amsterdam. The Foundation began its activity after the deaths of Ostrowski and his wife.

Atiyah To Head Trinity College and New Institute

Sir Michael Atiyah has been appointed Master of Trinity College of the University of Cambridge. In this position, considered to be one of the top two academic positions in the United Kingdom, he will be the administrative head of the largest and wealthiest College in Cambridge. He was formerly at Oxford University.

Sir Michael will also become the first director of the Isaac Newton Institute for Mathematical Sciences, which is being established at Cambridge. This research institute, which will be similar to the Mathematical Sciences Research Institute in Berkeley, will begin operation in July 1992.

In addition, Sir Michael will serve, beginning in November 1990, as the next President of the Royal Society. He will also be the AMS Gibbs Lecturer at the Joint Mathematics

Meetings in San Francisco in January 1991.

Conference Board of the Mathematical Sciences

On the occasion of the thirtieth anniversary of its founding, the Conference Board of the Mathematical Sciences (CBMS) honored G. Baley Price, Professor Emeritus of mathematics at the University of Kansas, at a reception and dinner. The celebration was held Friday, May 4, 1990, in the new offices of CBMS. Dr. Price was CBMS' first Acting Chairman.

The reception was attended by the presidents and/or representatives of the fifteen CBMS member societies, executive directors of the Mathematical Association of America, the Joint Policy Board for Mathematics, the Mathematical Sciences Education Board and the National Academy of Sciences project MS2000, former CBMS administrative officers, and several of the NSF's Division of Mathematical Sciences officers.

An inscribed plaque was presented to Dr. Price in grateful recognition for his vision in helping foresee the importance to the mathematical community of strong Washington representation; for leadership in founding CBMS and leading it to formal incorporation on February 29, 1960; for energy in serving as the first Chairman of CBMS during 1958-59 and then as its first Executive Secretary in 1960-61; and for contributions to the mathematical community sustained over a period of six decades.

IEEE Honors Four Mathematicians

In a ceremony in San Francisco on February 28, 1990, the Institute for Electrical and Electronic Engineers Computer Society (IEEE-CS) presented to the Office of Naval Research (ONR) the Computer Pioneer Award for significant contributions to the early concepts and developments in the electronic computer field. This is the first time the IEEE-

CS has recognized an organization for its research achievements.

At the same ceremony, IEEE-CS also honored four mathematicians who were considered the most outstanding computer pioneers at ONR. They were: MINA REES, who was the first head of the mathematics branch at ONR in 1946; the late JOACHIM WEYL, who came to ONR in 1947; MARSHALL C. YOVITS, who was head of the Information Systems Branch at ONR in 1956; and the late GORDON GOLDSTEIN, who came to ONR in 1956 and worked closely with Yovits.

Mathematical Society of Japan Prizes

The Mathematical Society of Japan has announced a number of prizes awarded to Japanese mathematicians. The 1990 Spring Prize of the Mathematical Society of Japan went to HIROSHI MATANO of the University of Tokyo for his outstanding contribution to the study of infinite dimensional dynamics and non-linear partial differential equations. AKITO FUTAKI of the Tokyo Institute of Technology received the 1990 Geometry Prize, in recognition of the Futaki invariant he introduced in connection with the existence of the Kähler-Einstein metric on a complex manifold. The 1990 Japan Academy Prize was awarded to SHIGERU IITAKA of Gakushuin University, SHIGEFUMI MORI of Kyoto University, and YUJIRO KAWAMATA of the University of Tokyo for their outstanding contribution to the theory of classification of algebraic varieties.

Elections to American Academy of Arts and Sciences

The American Academy of Arts and Sciences (AAAS) was founded in 1780 by John Adams and other leaders of the American Revolution and is an international honorary society. As a leading force in American intellectual life for more than two centuries, the AAAS has a current

membership of over 3000 scientists, artists, business and public figures, including 148 Nobel Laureates and 58 Pulitzer Prize Winners. The purpose of the Academy, as set forth in its original 18th-century charter, is to "cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people."

Among the 96 individuals recently honored by election to the AAAS were five mathematicians: RUTH M. DAVIS of The Pymatuning Group, Arlington, VA, SOLOMON FEFERMAN of Stanford University, ROBERT P. LANGE of the Institute for Advanced Study in Princeton, DAVID SLEPIAN of AT&T Bell Laboratories, and CLIFFORD H. TAUBES of Harvard University. In addition, H.S.M. COXETER of the University of Toronto and MARK VISHIK of the University of Moscow, were elected as Foreign Honorary Members.

Gordon Bell Awards Announced

Two computer models for problems connected to oil reservoirs received Gordon Bell Prizes in an annual competition given by Gordon Bell, vice president of Ardent Computer. Bell plans to give two prizes of \$1,000 each for ten years, in order to stimulate advances in practical applications of parallel computing.

The prize in the raw performance category went to a team of researchers from Mobil Research and Development and from Thinking Machines Corporation. The team used a Connection Machine 2 with 65,536 processors to produce a finite-difference seismic model that achieved the outstanding performance rate of 5.6 gigaflops. The program ran six times faster than last year's winning program.

The price/performance award went to Philip Emeagwali of the University of Michigan. His oil reservoir simulation model, also implemented on a Connection Machine 2, achieved

365 megaflops per million dollars, a sevenfold improvement over last year's winning entry.

The deadline for next year's competition is **December 31, 1990**. Entries should be sent to Gordon Bell Prize, c/o IEEE Software, P.O. Box 3014, Los Alamitos, CA 90720-1264. The competition rules were published in the May 1990 issue of *IEEE Software*, which administers the competition.

Winners of the U.S. Math Olympiad

Eight mathematically talented students have won Olympiad Medals in the 19th annual USA Mathematical Olympiad (USAMO). The winners were honored on June 6, 1990 at an awards ceremony and dinner, held at the National Academy of Sciences and the State Department in Washington, DC. The three-stage competition involved nearly 400,000 students nationwide.

The eight USAMO winners are: KIRAN S. KEDLAYA, Georgetown Day High School, Washington, DC; JEFFREY M. VANDERKAM, North Carolina School of Science and Mathematics, Durham, NC; A. HUGH R. THOMAS, Kelvin High School, Winnipeg, Manitoba, Canada; JÁNOS CSIRIK, Lester B. Pearson College, Victoria, British Columbia, Canada; DANIEL R. L. BROWN, Earl Haig Secondary School, North York, Ontario, Canada; JOEL E. ROSENBERG, William H. Hall High School, West Hartford, CT; ROYCE Y. PENG, Rolling Hills High School, Rolling Hills Estates, CA; JONATHAN T. HIGA, Iolani School, Honolulu, HI.

One hundred forty-one selected students took the rigorous examination designed to test problem solving ingenuity as well as knowledge of mathematics. The USAMO competitors were the top performers in two earlier competitions, the American High School Mathematics Examination and the American Invitational Mathematics Examination,

held in schools throughout the U.S. and Canada in March.

Following the awards ceremony, eligible winners and sixteen other students who did well on the USAMO participated in an intensive, four-week training session at the U.S. military academy at West Point. The purpose of the training session is to prepare a U.S. team of six students for the 1990 International Mathematical Olympiad (IMO), to be held in Beijing, China, July 8-19, 1990. The training session also prepares students for IMOs in subsequent years.

Romania initiated the IMO in 1959, and the U.S. has participated in the contest since 1974. Typically, 30-35 nations send teams to the competition. The U.S. team has usually placed among the top three nations in this prestigious competition, and in 1977, 1981, and 1986, the U.S. earned first place. Last year, China received the top honors, while the U.S. placed fifth.

Call for Nominations for Waterman Award

The National Science Foundation (NSF) is seeking nominations for the 16th annual Alan T. Waterman Award. This prestigious award is intended to recognize an outstanding young researcher in any field of science, mathematics, or engineering, and to encourage further high-quality research.

The award consists of a medal and up to \$500,000 for up to three years of research or advanced study. The award was established by Congress in 1975 to mark the 25th anniversary of the NSF and to honor Alan T. Waterman, the first director of the Foundation.

Candidates must be U.S. citizens or permanent residents and not be 35 years old or younger, or not more than five years beyond the receipt of the Ph.D. degree by December 31, 1990. Candidates should have sufficient personal accomplishments, outstanding capability, and

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exceptional promise for significant future achievement. Previous Waterman awardees in the mathematical sciences include Charles Fefferman, William P. Thurston, and Edward Witten, all of Princeton University, and Harvey Friedman of Ohio State University.

Nominations for the award may be submitted by individuals, professional societies, industrial companies, or other appropriate organizations within the scientific and educational communities. Nominations for the 1991 award must be received by **December 31, 1990**. Additional information and a copy of the nomination form may be obtained by contacting Susan E. Fannoney, Executive Secretary for the Alan T. Waterman Award Committee, 202-357-7512.

Reorganization of Education at NSF

In a reorganization of the Science and Engineering Education (SEE) directorate, the National Science Foundation (NSF) has relieved Bassam Z. Shakhashiri of his duties as Assistant Director for SEE. In that position, Shakhashiri was near the top of the NSF hierarchy and oversaw educational programs at all levels, including graduate fellowship programs and the calculus curriculum development program. Taking Shakhashiri's place as head of the reorganized directorate is Luther S. Williams, Senior Science Adviser to NSF Director Erich Bloch.

The removal of Shakhashiri follows a time of tension between him and Bloch, during which Shakhashiri took a high-profile position with Congress and the press in demanding large increases for NSF's educational activities. In asserting its own priorities within the Administration's request for the NSF budget, Congress has in recent years granted larger increases to SEE than had been requested, while paring away at the request for research activities. Part of the reason for the large increases for SEE is that its budget was effectively zeroed by the Reagan Administra-

tion, and it has taken a number of years of steady increases to put SEE back on its feet. Still, Shakhashiri was advocating tripling the SEE budget to \$600 million by 1993, while Bloch's goal for the Foundation overall has been to double its budget. Both requests met with sympathy in Congress, but the SEE budget has increased more rapidly than that of the rest of the NSF.

Over the past few months, plans for a reorganization of SEE were circulated within the Foundation. The draft plans, formulated by a committee chaired by Williams and consisting for the most part of the Assistant Directors of the NSF, focused mainly on ways of shifting more of NSF's educational activities to its research divisions. Some of the ideas the committee considered would have produced substantial changes in NSF's educational activities.

In the end, the reorganization mainly consisted of a name change from SEE to Education and Human Resources (EHR) and of moving programs for minorities, women, and the disabled to EHR from the directorate for Scientific, Technological, and International Affairs. Still, it is unclear whether other changes will be forthcoming before Bloch leaves the NSF when his term ends in August of this year. His successor had not been named at the time of this writing.

Shakhashiri has been on leave for the last six years from the University of Wisconsin, where he is a chemistry professor. An NSF staff member said that Shakhashiri was asked by the university to make a final decision this year about whether or not he was returning. Shakhashiri's plans at the time of this writing were not known, but an NSF news release said that he will join the NSF Director's office.

Williams, a biologist, held professorships at the Massachusetts Institute of Technology and Purdue University (where he was Director of the Minority Center for Graduate Education) before becoming Dean of

the Graduate School at Washington University in St. Louis. In addition, he was Vice-President for Academic Affairs at the University of Colorado, President of Atlanta University, and Deputy Director for the National Institute of General Medical Sciences. He has also served on a number of government science policy committees and currently chairs the White House Biotechnology Science Coordinating Committee. He came to the NSF in 1989.

Litigation Brought Against AMS Over Pricing Survey

The AMS is the target of litigation filed in the Federal Republic of Germany as a result of an AMS survey of prices of mathematics journals, published in the November 1989 issue of *Notices*.

The litigation, filed by Gordon & Breach (G&B) Science Publishers, Inc., claims the survey is "unfair competition" (comparative advertising), because G&B journals were found to be among the most expensive in the survey, while certain AMS journals were ranked in the bottom third. G&B attributes the price disparity to alleged "flaws" in the methodology of the survey.

The case follows close on the heels of similar litigation filed by G&B in the same German court against the American Physical Society (APS), the American Institute of Physics, and Henry Barschall, a retired physics professor at the University of Wisconsin. Both suits have provoked widespread criticism of G&B among librarians and scholars.

In an article in the *Chronicle of Higher Education* (October 25, 1989), which focused on the suit against APS *et al*, Patricia W. Berger, president of the American Library Association, was quoted as saying: "It looks to me like what [G&B] are trying to do is international harassment... There is no question but that this is intimidation." In the same article, Duane E. Webster, executive

director of the Association of Research Libraries, said G&B are trying to "protect their own product at the expense of freedom of inquiry." The article quoted him as saying that G&B are attempting to "create a chill on discussion, examination, and debate on serial pricing and quality, and discourage the exploration of causal factors and skyrocketing costs."

To air their views on the AMS survey, G&B took out a paid advertisement in the January 1990 issue of *Notices* (pages 92-93). G&B claim that the AMS survey contained "inconsistencies and inaccurate conclusions" because of "the use of inaccurate methodology, which results in overstatement of Gordon and Breach's prices by as much as a factor of two." In an editorial in that same issue of *Notices* (pages 2 and 18), William H. Jaco, executive director of the AMS, stated that "most of G&B's objections to the methodology are familiar ones and apply equally to most journals." G&B are free to dispute the methodology of the survey, he wrote, but they should not use letters from lawyers to "threaten the collection and dissemination of information."

G&B headquarters are in New York and London, and their major market appears to be in the U.S. and Great Britain. Yet no lawsuit has been filed in either of these countries. It is believed that G&B sued in Germany in the hope that German law, which prohibits certain kinds of "comparative advertising" that U.S. law permits, would favor their case. The AMS has learned, however, that G&B's suit against APS *et al* has just been dismissed by the German court.

At the time of this writing, the court had not yet reviewed the AMS suit. In February of this year, before it had heard full argument of the APS suit, the court did grant an injunction against further distribution of the AMS survey in Germany. The court did so based on a court appearance by G&B, made without notice to the AMS, and on various representations

made by G&B to the court.

Those interested in more information about the suit may consult the following references. In *The Scientist*: "Science Publisher Sues Over Journal Pricing Survey," September 4, 1989; "Publisher Continues Its Fight Against Price Surveys," February 5, 1990; "Publisher Blocks West German Mailing of Journal," May 14, 1990. In the *Chronicle of Higher Education*: "Critics Say Publisher's Suit Inhibits Inquiries Into Rising Journal Costs," October 25, 1989; Letters to the Editor, January 3, 1990 and January 24, 1990. In *Nature*: "Battle over value of words," September 28, 1989. In *Science*: "Gordon & Breach Impanels a Journal Jury," April 20, 1990.

DMS Advisory Committee Meeting

The Advisory Committee for the Division of Mathematical Sciences (DMS) at the National Science Foundation (NSF) will hold its autumn meeting November 1-2, 1990, at NSF headquarters in Washington, DC. The Committee discusses a range of policy issues facing the DMS and provides advice on setting priorities and formulating plans.

At the last meeting, the Committee discussed the idea of small research grants, salary caps on NSF grants, the role the DMS should play in educational activities and funding priorities within the DMS, among other topics. The meeting also included a session with NSF Director Erich Bloch. Mary Wheeler of Rice University currently chairs the Committee.

The meeting is open to the public, and interested members of the mathematical sciences community are invited to attend. Suggestions for topics of discussion may be made to Judith S. Sunley, Director, Division of Mathematical Sciences, National Science Foundation, Room 339, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-9669. Those wishing to attend the meeting should con-

tact Trudy Sensibaugh at the same address and telephone number.

1990 Mathematical Sciences Department Chairs Colloquium

The 1990 Mathematical Sciences Department Chairs Colloquium, sponsored by the National Research Council's Board on Mathematical Sciences (BMS), will be held on October 19-20, 1990, in the Washington, DC area. The theme of the 1990 colloquium is "Departmental Outreach." The program is designed to provide information chairs may use to foster departmental interaction with various constituent groups and external agencies.

In addition to a broad-based panel presentation/discussion on departmental outreach, the program includes: a report by the Committee on the Mathematical Sciences in the Year 2000 (MS 2000), panels on women and minorities in mathematics, and the teaching of statistics in mathematics departments. The program also includes two panels of representatives of federal agencies that fund mathematical sciences projects: one panel will discuss programs concerned with education and the second will provide information concerning research oriented programs. Ample opportunity will be provided for personal interaction with representatives of these agencies in both formal and informal settings.

Chairpersons may be particularly interested in the workshop on renewing U.S. mathematical sciences departments based on the recent BMS report, *Renewing U.S. Mathematics: A Plan for the 1990s* (the David II Report), and related MS 2000 reports. In June a workshop involving about one dozen experienced chairpersons was held at the National Academy of Sciences. The participants developed a draft plan for renewing U.S. university mathematical sciences departments, along with materials to support briefings by chairpersons to university faculty and administrators on the report and related efforts. The

products of this workshop will be brought forward to the Chairs Colloquium. There, these materials will be discussed and refined and made available soon thereafter to all U.S. university mathematical sciences department chairpersons. The materials are intended as tools that, if widely used, should strengthen the hands of chairpersons as they work to improve support for their individual departments.

Each year, the Chairs Colloquium provides a unique opportunity for mathematical sciences department chairs, federal agency representatives, and other interested parties to meet and discuss issues of mutual concern in a pleasant and stimulating setting. The registration fee is \$160 and includes all Colloquium sessions, materials, and related meals and social activities. Early registration is advised.

For further information, contact the Board on Mathematical Sciences at 202-334-2421. The mailing address is: Board on Mathematical Sciences, National Research Council, 2101 Constitution Ave., N.W., Room NAS 312, Washington, DC 20418.

Tits to Give Pitcher Lectures

The next series of Everett Pitcher Lectures will be held November 14, 15, and 16, 1990 on the campus of Lehigh University in Bethlehem, Pennsylvania. They will be delivered by Professor Jacques Tits of the College of France. The title of his lectures is *Monster and Moonshine: A Survey*.

The lectures are open to the public and are held in honor of Everett Pitcher, former Secretary of the AMS, who served in the Mathematics Department at Lehigh University from 1938 until 1978, retiring as Distinguished Professor of Mathematics. Further information can be obtained by writing Pitcher Lecture Series, Department of Mathematics, Lehigh University, Bethlehem, PA 18015, or by calling: 215-758-3753.

Tenth International Congress of Logic, Methodology, and Philosophy of Science

The Division of Logic, Methodology, and Philosophy of Science of the U.S. National Committee for the International Union of History and Philosophy of Science is seeking a host for the Tenth International Congress of Logic, Methodology, and Philosophy of Science to be held in 1995. Since the founding meeting in Stanford, California, in 1960, meetings have been held in Israel, The Netherlands, Rumania, Canada, Germany, Austria, and the USSR. It would now be appropriate for a meeting to be held at a United States based institution or consortium of institutions. Although the official invitation to hold the meeting in the United States will be issued by the National Academy of Sciences, funding of the order of \$130,000 would have to be obtained from other sources. Secure financial arrangements between the host institution and the Academy must be in place well before the next DLMPS meeting in August 1991. Realizing that it may prove impossible to find an appropriate host in time for the 1995 meeting, the U.S. National Committee also encourages suggestions for the Eleventh Congress in 1999. For further information:

Milton A. Whitcomb, Staff Officer
U. S. National Committee for the International Union of History and Philosophy of Science (HA 186)
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
Telephone: 202-334-3022

Visiting Scientist Guidelines Available

The Visiting Scientist Program of the Colorado Alliance for Science has published "Guidelines for Your Visiting Scientist Program," which provides advice for programs in which scientists donate their time and expertise to assist classroom teachers. The Alliance's program has been run-

ning in schools in four Colorado cities since 1983.

Among the main aspects of the Colorado program are: (1) a scientist or engineer from industry donates two to five hours per week to a teacher or department; (2) work may be done at any grade level; (3) teacher/scientist teams collaborate on plans for projects; (4) the team continues its efforts for at least one school year; (5) evaluation is an ongoing process between the teacher and the scientist.

There is considerable evidence from the Colorado experience that such programs can enhance student learning, teacher effectiveness, and communication between industry and schools. To obtain a copy of the guidelines, write to: James H. Hubbard, Associate Director, Colorado Alliance for Science, Campus Box 249, University of Colorado, Boulder, CO 80309.

Mathematics Awareness Week 1991

April 21-27

Right on the heels of Mathematics Awareness Week 1990, plans are being made for next year's celebration of the richness and relevance of mathematics. Dates for 1991 are April 21-27 and the theme will focus on the uses of mathematics.

The Office of Governmental and Public Affairs (OGPA) of the Joint Policy Board of Mathematics is seeking slogans and art work for this "applications" theme.

Please send your ideas by **September 30, 1990** to: OGPA, 1529 18th Street, N.W., Washington, DC 20036.

The originator(s) of the chosen theme and art work will receive credit on printed materials as well as a free supply of posters and postcards.

News from the Institute for Mathematics and Its Applications University of Minnesota

The 1990-1991 academic year program at the Institute for Mathemat-

ics and Its Applications (IMA) is Phase Transitions and Free Boundaries. The organizers for this program are: R. Fosdick, M.E. Gurtin, W.-M. Ni, and L.A. Peletier. The advisory committee is: H. Brezis, L.A. Caffarelli, D. Kinderlehrer, and J. Serrin. The aim of the program is to understand certain types of physical behavior which occur in phase transitions and in phenomena which involve free boundaries.

The first half of the year will be concerned with phase transitions and will concentrate on equilibrium and dynamical problems involving two or more phases, with the transition region a sharp interface or a transition layer. The program will begin September 10-14 with a tutorial, *The Evolution of Phase Boundaries*, organized and led by M. Gurtin. The goal of this minicourse is a coherent treatment of the continuum mechanics and thermodynamics of evolving phase boundaries. The tutorial will be followed immediately by the workshop *On the Evolution of Phase Boundaries*, September 17-21, organized by Gurtin and G. McFadden.

During October 15-19 the IMA will offer the workshop *Shock Induced Transitions and Phase Structures in General Media*, organized by R. Fosdick, E. Dunn, and M. Slemrod. This workshop will focus on the thermodynamics and mechanics of dynamic phase transitions that are mainly inertially driven.

On November 12-16 the workshop *Microstructure and Phase Transition* will be held, organized by D. Kinderlehrer, R. James, J.L. Ericksen, and M. Luskin. The emphasis here will be the discussion of phase transitions, defect structures and metastability, especially in solids, from the viewpoint of experiment, constitutive theory, and the development and use of numerical results to reconcile experiment with theory.

The phase transitions portion of the program will conclude with the workshop *Statistical Thermodynam-*

ics and Differential Geometry of Microstructured Material, (January 21-25, 1991), organized by H.T. Davis and J.C.C. Nitsche. The purpose is to bring together researchers interested in the generation of statistical mechanical free energy theories which predict the appearance of the various microstructures, in the development of the topological and geometrical methods needed for a mathematical description of the subparts and dividing surfaces of heterogeneous materials, and in the development of modern computer-aided mathematical models and graphics for effective exposition of the salient features of microstructures materials.

At present, the IMA is running a 1990 summer program *New Directions in Time Series Analysis* (July 2-27), organized by E. Parzen, D. Brillinger, M. Rosenblatt, M. Taqqu, J. Geweke, and P.E. Caines. The weekly topics are non-linear models, self-similar processes & long range dependence, interactions of time series & statistics, and time series research common to engineers & economists.

For more details concerning the summer and academic year programs, contact the IMA at Institute for Mathematics and its Applications, University of Minnesota, 514 Vincent Hall, 206 Church St. S.E., Minneapolis, MN 55455-0436; 612-624-6066.

News from the Mathematical Sciences Institute Cornell University

A workshop on Partial Differential Equations is planned for October 5-7, 1990 at the Mathematical Sciences Institute (MSI). Organized by Alfred Schatz and James Bramble of Cornell University, this workshop honors the contributions of Lawrence E. Payne during his 25 years as a professor in Cornell's Department of Mathematics. Topics to be discussed within the general area of partial differential equations include: non well-posed prob-

lems, isoperimetric inequalities, and finite time blowup. The workshop will be held at Cornell University. For information about scientific content, contact A. Schatz, Department of Mathematics, Cornell University, Ithaca, NY 14853; 607-255-2318; schatz@mssun7.msi.cornell.edu. To attend the workshop, contact the Mathematical Sciences Institute, 201 Caldwell Hall, Cornell University, Ithaca, NY 14853; 607-255-8005.

News of the MSI, including workshop overviews, can be received free of charge in its newsletter *Mathematical Sciences Institute News*; write to John Chiment at MSI, 223 Caldwell Hall, Cornell University, Ithaca, NY 14853. A summary of the invited talks and of the panel discussion which took place at the March "Mathematics as a Consumer Good" symposium (*Notices*, November 1989, page 1218) is now available from MSI at the address in the first paragraph.

Italian Society of Applied and Industrial Mathematics

The Italian Society of Applied and Industrial Mathematics (SIMAI) has been established to encourage the development of applied and industrial mathematics and related disciplines. The aim is to facilitate interactions among universities, research institutions, and industries in the various fields of applied mathematics. In this connection, SIMAI is particularly concerned with the development of mathematical models, the study of their qualitative properties, and the numerical and computational questions they pose.

SIMAI also intends to develop programs to train young mathematicians, to update senior researchers in applied and industrial mathematics, and plans to develop postgraduate courses, interdisciplinary study groups, and a program of grants for young researchers. In addition, SIMAI will publish a newsletter, encourage national and international symposia and seminars, and may

eventually publish texts growing out of its educational programs.

For more information about SIMAI, contact: A. Tesei, c/o Istituto per le Applicazioni del Calcolo "M. Picone," Viale del Policlinico 137, I-00161 Roma, Italy.

Mathematics Education Centre, Auckland

The Mathematics Education Centre, Auckland (MECA) was formed in 1989 to act as a focus both for mathematical education and for the users of mathematics within industry, commerce, and the community. Involving a wide range of education groups, the Centre supports all aspects of mathematics education, with an emphasis on research, professional development for teachers, and resource development. In addition, MECA works with communities to promote mathematics teaching and learning, and publishes regular newsletters.

MECA also issues *MECATALK*, which appears three times per year. For more information about MECA, write to: Jill Ellis, Director, MECA, c/o Auckland College of Education, Private Bag, Symonds Street, Auckland, New Zealand; telephone 09-687-009.

Linear Algebra Society Formed

The International Linear Algebra Society (ILAS) was formed during the Combinatorial Matrix Analysis Conference in Victoria, Canada, in May 1987. Encompassing all applications of linear algebra, as well as theoretical matrix analysis and abstract linear algebra, ILAS is designed to encourage and support such activities as meetings and publications.

The inaugural ILAS meeting took place in Provo, Utah, in August 1989. Other ILAS conferences are being planned, and ILAS is also sponsoring several other linear algebra conferences. Other ILAS activities include: publication of *Image*, a bulletin which provides a forum for discussions and opinions; ILAS-NET,

an electronic news service which transmits announcements of ILAS activities and other news of interest to linear algebraists; and ILAS Information Center, an on-line system providing information on international linear algebra conferences and on linear algebra journals, as well as other news.

More information about ILAS is available through email, by sending the message "send gen_info from ilas" to iic@water.uwaterloo.edu or to iic@water.waterloo.edu. Or contact Danny Hershkovitz, ILAS Secretary, Mathematics Department, Technion-Israel Institute of Technology, Haifa 32000, Israel; email mar23aa@technion.bitnet.

Committee Addresses

Mathematics in Genome Project

The Societal Institute of the Mathematical Sciences (SIMS) has organized a steering committee to address the role of the mathematical sciences in the Human Genome Project. The committee will monitor rapid developments in the project and related fields which particularly concern the mathematical sciences and will recommend or initiate research and education programs when desirable or necessary.

"The understanding of DNA and protein sequences and structure is perhaps the most fundamental problem facing biology today," says one of the committee members, James G. Glimm of the State University of New York at Stony Brook. "A number of areas of mathematics have proven to be relevant to this kind of problem: analysis, combinatorics, computer science, discrete optimization, mathematical and dynamic programming, numerical analysis, probability, statistics, stochastic processes, and topology." Another committee member, Samuel Karlin of Stanford University, notes that "there are great opportunities for mathematicians, statisticians, and computer scientists to bring their unique and creative scientific ap-

proaches to theoretical and data analysis problems of the Human Genome Project and make useful contributions."

It is anticipated that the committee will meet five times during the period 1990-92. A written record will be prepared following each meeting and made available to those interested. SIMS, founded in 1973 as a non-profit institute, conducts conferences and research and education programs in the application of the mathematical sciences to societal issues. For more information, write to: SIMS, 97 Parish Road South, New Canaan, CT 06840.

Hotline for NSF Vacancies

The National Science Foundation has installed a Vacancy Hotline, which lists all current vacancies in staff positions. For those in the District of Columbia metropolitan area, the local hotline number is 202-357-7735; others may call 800-628-1487.

NSF Links Researchers to Japan

The National Science Foundation (NSF) is offering U.S. scientists and engineers access to scientific information from Japan. In cooperation with Japan's National Center for Science and Information Systems (NACSIS), the NSF provides, at no charge, on-line access to the science databases associated with Japan's Ministry of Education, Science, and Culture.

As of March 1990, ten databases were available, including Grant-in-Aid Research Reports, Conference Papers of Academic Societies and Associations, and Index to Dissertations. The NSF will, at the request of a researcher, perform a search and summarize the findings in English. Or, researchers may arrange to come to NSF headquarters in Washington, DC, to use the facility in person.

For more information, contact: NACSIS Search Operator, Room 416-A, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-7278.

Report Finds Data Lacking on Teacher Quality

News headlines warn of shortages of mathematics and science teachers, but a panel of the National Research Council says that quantity is not the only issue. Quality is equally, if not more, important in understanding the state of the nation's precollege mathematics and science education. The panel's report concluded that too little is known about the quality of mathematics and science teachers in the United States and recommended improved data collection through extensive surveys administered on a regular basis. The report is the result of a thirty-month review that included in-depth studies of thirty-nine school districts across the nation.

The report states that more must be done to collect and analyze data on all aspects of the pool of mathematics and science teachers, from the reasons teachers leave the field to information on the hiring practices of school systems. Of primary

concern is the lack of frequent and detailed attrition data, needed to predict the demand for teachers, the report notes. Population projections help school districts determine the number of teachers needed for a given year, but it is much more difficult to predict the numbers of qualified teachers available. Frequently, school districts adjust to changes in supply and demand by lowering their hiring standards or shifting teachers from one subject area to another. Such adjustments can dramatically change the quality of instruction.

The report recommends that school districts be surveyed regularly by the U.S. Department of Education's National Center for Education Statistics. Addressing the shortage of minority teachers is also a priority. The report, "Precollege Science and Mathematics Teachers: Monitoring Supply, Demand, and Quality," is available for \$25 (prepaid) from the National Academy Press, 2101 Constitution Ave., Washington,

DC 20418; 202-334-3313 or 800-624-6262.

Brochures on Graduate Support Available

To help address the decline in the number of students expressing interest in graduate school, the National Science Foundation (NSF) has prepared a brochure, "Thinking of Graduate School?". This handy brochure briefly describes various graduate fellowship opportunities available through the NSF. Colleges and universities nationwide are being asked to distribute the brochures to alert juniors and seniors in science, mathematics, and engineering to these fellowship opportunities.

These brochures are available free of charge from the National Research Council. To order copies, send your name, institution, department, and address to: Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington, DC 20418. Please indicate the number of copies desired.

NOMINATIONS FOR THE 1991 FULKERSON PRIZE

This is call for nominations for the D. Ray Fulkerson Prize in discrete mathematics that will be awarded at the XIVth International Symposium on Mathematical Programming to be held in Amsterdam, The Netherlands, August 5 - 9 1991.

The specifications for the Fulkerson Prize read:

"Papers to be eligible for the Fulkerson Prize should have been published in a recognized journal during the six calendar years preceding the year of the Congress. This extended period is in recognition of the fact that the value of fundamental work cannot always be immediately assessed. The prizes will be given for single papers, not series of papers or books, and in the event of joint authorship the prize will be divided.

"The term 'discrete mathematics' is intended to include graph theory, networks, mathematical programming, applied combinatorics, and related subjects. While research work in these areas is usually not far removed from practical applications, the judging of papers will be based on their mathematical quality and significance."

The nominations for the award will be presented by the Fulkerson Prize Committee (Martin Grötschel, Chairman, Louis Billera, and Paul D. Seymour) to the Mathematical Programming Society and the American Mathematical Society.

Please send your nominations by **January 15, 1991** to:

Professor Dr. Martin Grötschel
Institute of Mathematics, University of Augsburg, Universitätsstr. 8, 8900 Augsburg, West Germany

Funding Information for the Mathematical Sciences

AMS Centennial Fellowships Invitation for Applications, 1991-1992 Deadline December 1, 1990

These fellowships are intended to provide enhanced research opportunities to mathematicians who are several years past the Ph.D., who have a strong research record, but who have not had extensive postdoctoral research support in the past. Applicants should have received the Ph.D. degree between January 1, 1979, and December 31, 1984, and should not have had the equivalent of more than two years of full-time postdoctoral support.

The stipend for fellowships awarded in 1991-1992 has been set by the Trustees of the Society at \$38,000 for nine months. In addition, there will be an expense allowance of

\$1,200. Applicants must be citizens or permanent residents of a country in North America. The fellowship may be combined with other stipends and/or part-time teaching; this option can be used to extend the award to cover a period of up to two years. For further information about the acceptability of such arrangements, individuals should contact the Secretary of the Society.

The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Trustees have arranged a matching program from general funds in such fashion that funds for at least one fellowship

are guaranteed. Because of the generosity of the AMS membership it was possible to award three fellowships a year for the past three years (1988-1989, 1989-1990, and 1990-1991).

The deadline for receipt of applications is **December 1, 1990**. Awards will be announced in February 1991, or earlier if possible.

For application forms, write to the Executive Director, American Mathematical Society, P.O. Box 6248, Providence, RI 02940. (It should be noted that completed application and reference forms should NOT be sent to this address, but to the address given on the forms.)

NSF Proposal Format Changes - Update

The October 1989 issue of *Notices* carried an announcement concerning a number of changes in the format of proposals submitted to the National Science Foundation. The purpose of the changes was to address two issues: the quality of publications of the investigators and the educational impact of the proposed research. One of the changes was to limit to ten the number of publications listed on the proposal.

The Foundation has announced that, until further notice, the proposal format changes have been suspended. In particular, every investigator is encouraged to include in

his or her vita a complete list of publications.

New Program for Women Faculty

The National Science Foundation has launched this year a new program to recognize the nation's most outstanding and promising women scientists, mathematicians, and engineers who are engaged in academic research and teaching. The Faculty Awards for Women program will make up to 100 five-year grants of \$50,000 per year to support research activities.

Nominations for the awards must be made by a sponsoring institution. To be eligible, nominees must be U.S. citizens, hold a Ph.D. (or an

equivalent degree), and be tenured but not yet full professors (or the equivalent rank). There is no limit on the number of nominees from an institution, but there should be only one nominee per department.

Institutions are expected to make a significant commitment to the support of their awardees, including full academic-year salary for the awardee. Up to 10% of the funds may be used to defray administrative expenses in lieu of direct costs.

The deadline for submission of nominations is **September 1, 1990**. The Division of Research Initiation and Improvement will be coordinating the program in the Foundation; the contact person there is Jean Van-

ski, 202-357-7552. In addition, the staff of the Office of Special Projects in the Division of Mathematical Sciences would be happy to answer questions about the program (202-357-3453).

Deadlines for International Programs

The National Science Foundation (NSF) has several programs supporting international collaborative research in science and engineering. These programs provide support for various kinds of projects, including cooperative research between individual investigators, long- and medium-term research visits for young researchers, and research-oriented seminars or workshops.

The Bilateral Cooperative Science Programs support cooperative research, seminars or workshops, and long-term visits (4-12 months) in Austria, Germany, the Netherlands, Denmark, Finland, Norway, Sweden, the United Kingdom, and Switzerland. For more information, contact Christine French or Christine Glenday, Division of International Programs, 202-357-9700. The deadline is **September 15, 1990**.

The Science in Developing Countries program supports short-term planning visits, collaborative research, seminars, and dissertation improvement of graduate students in developing countries. For more information contact Ed Field (North Africa and Turkey), 202-357-9402; Osman Shinaishin (South and West Asia), 202-357-9402; Gerald Edwards (East Asia), 202-357-9537; Harold Stolberg or David Kelland (Latin America and the Caribbean) 202-357-7421. Though proposals may be submitted at any time, the next target date is **September 1, 1990**.

Presidential Young Investigators Competition for 1991

Each year, the National Science Foundation (NSF) offers cooperative research support to 200 of the nation's most promising young science,

mathematics, and engineering faculty, through the Presidential Young Investigators program. In past years, these prestigious awards have totaled \$25,000 plus an additional \$37,500 on a dollar-for-dollar basis if matched with contributions from industrial sources. Total possible annual support is \$100,000.

Nominations must be made by U.S. institutions granting degrees in fields supported by the NSF. Although the program announcement was not available at the time of this writing, it is anticipated that the guidelines for the program will be similar to previous years. In particular, nominees must be no more than five years from the Ph.D. and must have begun their first tenure-track positions at eligible institutions within the last three years.

The application deadline is **October 1, 1990**. For a program announcement and more information, contact: Presidential Young Investigators Program, Room 630, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-9466.

Deadline for Research Experiences for Undergraduates

As part of ongoing efforts to enhance undergraduate experience in the mathematical sciences and stimulate students' interest in research careers, the Division of Mathematical Sciences (DMS) of the National Science Foundation sponsors the Research Experiences for Undergraduates (REU) program. One component of the program, the REU Sites, gives students an opportunity to participate in the excitement of research in intensive summer programs.

The REU Sites funded by DMS have been highly successful in attracting talented students and in providing them with challenging projects. Rather than providing additional coursework, the REU Sites are designed as enrichment experiences that give students a taste of mathematical sciences research.

Out of sixteen new proposals for REU Sites for the summer of 1990, there were nine new awards; there were also six continuing awards. The total DMS budget for the REU Sites is around \$0.5 million for fiscal year 1990. A list of the grantees, together with the titles of their projects, can be found in *Notices*, February 1990, page 141.

According to John V. Ryff, program director for REU in DMS, some of the guidelines for the program have changed slightly. Applicants need not confine budgets to the \$4000 per-student average. In addition, the DMS will now consider faculty salary and equipment requests along with student stipends. Meeting such requests is contingent upon budget flexibility within the DMS; however, Ryff notes that the DMS is currently planning to expand the REU Site program. The DMS strongly encourages proposals from all segments of the mathematical and statistical communities, and proposals for REU Sites in mathematical statistics are especially welcome.

The deadline to submit proposals for the 1991 REU Sites is **October 10, 1990**. For more information, contact John V. Ryff, Program Director, Research Experiences for Undergraduates, Division of Mathematical Sciences, Room 339, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone: 202-357-3456; electronic mail: jryff@note.nsf.gov (Internet) or jryff@nsf (Bitnet).

Deadline for NSA Research Proposals

The National Security Agency (NSA) awards research grants to universities in the areas of algebra, number theory, discrete mathematics, probability, and statistics. For standard research proposals designed principally to provide summer salary for professors and support for graduate students, the next deadline is **October 15, 1990**. Grants awarded from

Funding Information

proposals for this funding cycle can expect to incur expenses by June 1, 1991.

The NSA also accepts proposals for small grants for conferences, workshops, and special academic endeavors in the above five areas of mathematics. In previous years, these had a deadline of May 1, but now there will be **no deadline** for these types of proposals. The proposals will be accepted, reviewed, and funded as they are received at NSA. Those submitting the proposals should allow 7 to 8 months of review time before grants can be made.

For further information about the program, please call 301-859-6659 or write to Marvin C. Wunderlich, Director, Mathematical Sciences Program, National Security Agency, Attn. RMA, Ft. George G. Meade, MD 20755-6000. Queries can also be made by email at mcw@cs.umd.edu.

Mathematical Sciences

Postdoctoral Research Fellowships

The National Science Foundation's (NSF) Mathematical Sciences Postdoctoral Research Fellowship program is designed to permit recipients to choose research environments that will have maximal impact on their future scientific development. Awards

will be made for appropriate research in pure mathematics, applied mathematics and operations research, and statistics at an appropriate nonprofit United States institution.

The fellowships will be offered only to persons who 1. are U.S. citizens or nationals as of January 1, 1991; 2. will have earned, by the beginning of their fellowship tenure, a doctoral degree in one of the mathematical sciences; 3. will have held the doctorate for no more than five years as of January 1, 1991; and 4. will not previously have held any other NSF postdoctoral fellowship. The evaluation of applicants will be based, in part, on ability as evidenced by past research work and letters of recommendation, likely impact on the future scientific development of the applicant, and scientific quality of the research likely to emerge. Applicants' qualifications will be evaluated by a panel of mathematical scientists.

For copies of the application brochure or further information, contact the Special Projects Program, Division of Mathematical Sciences, National Science Foundation, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-3453; or the American Mathematical Society at telephone 401-455-4000.

The deadline for applications is **November 15, 1990.**

Travel Grants for Logic Congress

Travel grants will be available for the IX International Congress of Logic, Methodology and Philosophy of Science, which will be held in Uppsala, Sweden August 7-14, 1991. The grants are available from the International Union of the History and Philosophy of Science, under the aegis of the National Academy of Sciences.

An applicant must submit an application form together with a curriculum vitae, a list of recent publications, and an abstract of the paper to be presented at the Congress. Although acceptance of a paper at the Congress is not necessary to apply, the travel awards are conditional upon obtaining confirmation of receipt and acceptance of the paper. Applicants must be U.S. citizens.

The deadline for receipt of applications is **January 2, 1991.** For copies of the application form, contact: Milton A. Whitcomb, Staff Officer, National Research Council, U.S. National Committee for the International Union of the History and Philosophy of Science, 2101 Constitution Avenue (HA 186), Washington, DC 20418; telephone 202-334-3022.

Probability Theory, Function Theory, Mechanics

Yu. V. Prokhorov, Editor (Proceedings of the Steklov Institute, Volume 182)

This is a translation of the fifth and final volume in a special cycle of "Trudy of the Steklov Mathematical Institute of the Academy of Sciences," published in commemoration of the 50th anniversary of the Institute. The purpose of the special cycle of publications was to present surveys of work on certain important trends and problems pursued at the Institute. Because the choice of the form and character of the surveys was left up to the authors, the surveys do not necessarily form a comprehensive overview, but rather represent the authors' perspectives on the important developments.

The survey papers in this collection range over a variety of areas, including: probability theory and mathematical statistics, metric theory of functions, approximation of functions, descriptive set theory, spaces with an indefinite metric, group representations, mathematical problems of mechanics, and spaces of functions of several real variables and some of its applications.



1980 Mathematics Subject Classifications: 01, 04, 22, 34, 41, 42, 46, 62, 73, 76, 93 and others
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For Your Information

Mathematical Sciences in the FY 1991 Budget*

Joint Policy Board for Mathematics

Hans J. Oser

Overview and General Trends

The substantial increases in support of research in mathematical science during the 1980s have generally given way to a more modest growth as seen in the proposed fiscal year 1991 federal budget. During the early eighties many funding agencies experienced annual growth rates in excess of 10 percent in their mathematics programs. In the past few years, however, the worsening federal deficit, combined with the effects of the Gramm-Rudman-Hollings legislation, has substantially cut the rate of increase for these programs.

Although the National Science Foundation (NSF) has convinced the Administration again that the overall NSF budget should double by 1993, the last three years' experience urges caution on whether NSF can expect the 14 percent increase they are asking for. The oversight committees in both Houses of Congress have been sympathetic in recent years to the idea of doubling NSF's budget over a five-year period, but the prevailing budget realities have forced Congress to deny the Administration's request for three years in a row. Besides the Gramm-Rudman-Hollings legislation, the jurisdictional boundaries of the appropriations subcommittees in both Houses have been the most serious obstacle to granting NSF the special status that it would seem to deserve as one of the nation's major sources of support for basic research in science and engineering. NSF has suffered from the annual tug of war between its own budget request, the space program, and those highly visible programs for national housing for veterans' affairs, the latter now a cabinet-level department.

Neither the Department of Energy nor the funding agencies in the Department of Defense predict dramatic increases in support of R&D programs, although basic

research appears to come off better than many applied research and technology development programs.

The fragmentation of congressional responsibility concerning science and technology programs has prevented a meaningful dialogue on national R&D policy. This situation has frustrated members of the academic world who would like to see Congress discuss the issues of big science versus little science, the balance between defense-sponsored and civilian research, the growth, in numbers and size, of science, and technology centers versus single-investigator grants, as well as the potential impact of adding technology policy to NSF's duties.

Trends in Federal Support for Mathematics Between 1982-1990

In the NSF, mathematics has fared relatively well in the past eight years. Growth in the Division of Mathematical Sciences (DMS) during this period was 85 percent (in constant dollars) and even higher when mathematics-related support in other directorates is counted. Most of these increases went into development of an undergraduate mathematics curriculum. In FY 1991, the DMS is asking for a 6.7 percent increase (in current dollars), which is the second-highest in the Mathematical and Physical Sciences Directorate (MPS), after astronomy. Beginning in FY 1991, the NSF budget contains a new line item for facilities, for which \$20 million is being requested. Within MPS, those funds will be directed towards upgrading laboratory facilities in physics, astronomy, and materials science, none for mathematics.

In the Defense Department, the former rapid growth in support of basic research has declined to a modest 4 percent in FY 1991. How this overall increase in the so-called 6.1 programs will show up in the FY 1991 mathematical sciences programs in ARO, AFOSR, ONR, NSA and DARPA is not yet evident. Most of the DOD program managers indicate a practically level budget for 1991 compared to 1990. The overall growth in support of mathematics since 1982, in constant dollars, was 73 percent, but that growth has been quite uneven as we examine the five funding agencies more closely. NSA and DARPA did not directly fund mathematical science

*This report was prepared for the Joint Policy Board for Mathematics and as part of the AAAS Report XV: Research and Development, FY 1991, April 1990.

For Your Information

research in the universities prior to 1984. AFOSR and ARO show (constant-dollar) increases of 86 and 51 percent, respectively, while ONR suffered a 13 percent decline during the same period.

The Department of Energy is requesting an 11 percent increase in its mathematical sciences program for FY 1991. Past experience suggests that the final outcome will probably be closer to half that amount. The DOE Applied Mathematical Sciences Program supports both mathematics and computer science and divides its \$25 million budget about equally between the two disciplines. About half of the budget supports university-based research projects, the other half is channeled through the DOE National Laboratories. The mathematics support directed to the universities, in constant dollars, grew by an astounding 125 percent since 1982, the highest of any of the agencies covered in this survey. This DOE program also underwrites the Wilkinson Fellowship at Argonne National Laboratory, the Lewy Fellowship at Berkeley, and the Householder Fellowship at Oak Ridge National Laboratory, all fellowships that enjoy considerable prestige in the mathematics community.

Highlights of Mathematics Programs in FY 1990

The Army Research Office announced on August 24, 1989 that it had made a 5-year, \$66.9 million award to a consortium, led by the University of Minnesota, to establish an Army High Performance Computing Research Center on the Minneapolis Campus. The program envisioned by the Army will include research in the mathematical sciences, computer engineering, and physical and biological sciences. Other participants in this new center, besides the University of Minnesota, are the Massachusetts Institute of Technology, Howard University, and Purdue University. The center is expected to be fully operational in the Spring of 1990. Initially, access will be made available to super-computers such as the CRAY-2 and CRAY-XMP, later to be augmented by an aggressive equipment acquisition of massively parallel machines, high-performance workstations, and a visualization laboratory. The equipment budget during the 5-year lifetime of the project is \$27.3 million, the research budget is \$8.5 million, and infrastructure support will get \$31.1 million. The director of the center is George Sell, the scientific direction is provided by David Kinderlehrer in the School of Mathematics at Minnesota.

Automatic Gramm-Rudman-Hollings cuts forced NSF to postpone the start of new science and technology centers in FY 1990. The collapse of ETA-Systems, the Control Data Corporation's supercomputer subsidiary, led to an NSF decision in the directorate for Computer & Information Science and Engineering (CSE) to phase out support for the John von Neumann Center at Princeton University during the current fiscal year. The four remaining supercomputer centers (Illinois, Cornell,

Pittsburgh, and San Diego) will receive hardware and software upgrades in both FY 1990 and FY 1991.

Proposed Agency Programs in the 1991 Budget

Each funding agency provides support for a variety of programs including institutes, individual and group awards, equipment awards, and special programs in support of women and minority students. In addition, all agencies are funding a variety of cross-disciplinary programs, such as infrastructure support, equipment awards, fellowships for faculty and graduate students (including women and minority fellowships), and so-called small institution awards. Agency programs are also involved in cooperative funding arrangements across disciplines and sometimes jointly with other agencies. These include industrial, university, and laboratory cooperative programs. For these reasons it is very difficult to make precise statements about the level of funding for mathematical sciences research per se, since many of the funding agencies in DOD, NASA, and in DOE often describe their programs by projects and not by discipline.

Personnel changes have been quite minimal during the past year. The new director of the mathematics division in ONR is Neil Gerr who had been acting director of the division since the departure of John Cannon. Several new program directors were appointed in NSF, AFOSR, ONR and ARO.

A. National Science Foundation. Within the Mathematical and Physical Sciences Directorate (MPS), the FY 1991 request for mathematical sciences of \$73.72 million is up from \$69.12 million in 1990, a 6.7 percent increase in current dollars. The additional funds are for the Special Projects activity (undergraduate course and curriculum development, alliances for minority participation, and faculty awards for women), and in the programs area an increase of 20 new investigators, more support for graduate students and equipment, and strengthened research support in areas of opportunity, such as interaction with other disciplines, computational mathematics, and the incorporation of geometric ideas and methods throughout the mathematical sciences.

Both MPS and CSE have substantial increases for science and technology centers in their budget requests for next year, totalling \$15.25 million. The awards will not be made until late 1990, when the allocation to particular disciplines will be known.

B. Air Force Office of Scientific Research (AFOSR). Mathematical sciences research is supported within the Mathematical and Information Sciences Directorate. Support for mathematics is expected to increase from \$16.5 million in fiscal year 1990 to \$17.5 million in fiscal year 1991. Included in this figure are \$3 million for multidisciplinary and research interaction awards under the University Research Initiative Program and

about \$1 million going to support research in the Air Force laboratories. Major program areas supported by the AFOSR are nonlinear dynamics and control theory, optimization, finite mathematics, signal processing and communication, probability and statistics, and physical mathematics. There is an exploratory research program in wavelets.

C. Army Research Office (ARO). The Army High Performance Computing Research Center (AHPCRC) at the University of Minnesota is now in its first full fiscal year of operation. The research program at AHPCRC is directed towards mathematical and computer sciences, physics and biology. Programmatic thrusts are in the materials sciences, real-time control, computer science aspects in large-scale computing and in the biomedical sciences. ARO also supports the Mathematical Sciences Institute at Cornell University and the Center for Intelligent Systems at Brown and Harvard Universities.

D. Office of Naval Research (ONR). The Mathematical Sciences Division's program is divided into six areas: applied analysis, discrete mathematics, numerical analysis, operations research, probability and statistics, and signal analysis. The core program in FY 1990 is \$7 million and is expected to increase to almost \$8 million in 1991. The accelerated research initiatives (ARI) are short-term programs with typically a five-year lifetime. Their share of the mathematics budget this year is 4 million and is expected to go up to \$4.8 million in FY 1991. The total budget of the division will thus increase from \$11 million to \$12.7 million in FY 1991, a growth of over 15 percent in current dollars. This is the first substantial increase in several years for the mathematics program at ONR.

E. Defense Advanced Research Programs Agency (DARPA). Unlike the funding agencies of the three DOD Services, i.e., AFOSR, ARO, and ONR, the DARPA program is directed towards advanced technology development. Mathematical research is but one tool in the arsenal of techniques employed to further DARPA's goals. Furthermore, the distinction between applied mathematics, computer science and computer engineering is an exceedingly difficult one to draw in this environment. Consequently, the allocation of the agency's budget to particular disciplines is not entirely satisfactory in this case.

In FY 1990 the Applied Computational and Mathematics Program has a total budget of \$12 million. This program is primarily directed toward four specific areas. They are (1) modeling and simulation, (2) algorithmic development, (3) digital signal processing, and (4) intelligent control. This latter category of research is directed towards those aspects of control theory where the environment cannot be described by ordinary differential equations any more but has to be determined through modeling, simulation and heuristics. That also involves

the use of artificial intelligence (AI) methods for data management.

In digital signal processing, new tools are being developed, such as wavelets, Gabor bases, and Wigner transforms. Data fusion is a technique that is being used to combine information from the data to which different computations have been applied.

Algorithm development aims at codes for distributed systems, among them non-iterative algorithms for number-crunching in linear algebra problems. Another goal is the automation of optimal code generation that will match given algorithms to a particular machine.

F. National Security Agency (NSA). NSA's mathematical sciences program experienced a substantial increase from fiscal year 1989 to 1990, from \$2.9 million to \$3.2 million, or more than 10 percent. The outlook for fiscal year 1991 appears to be for a level budget.

The mathematical sciences program at NSA went public in 1984. It supports research in algebra, number theory, discrete mathematics, statistics and probability. Due to the nature of its work, the agency continues to be concerned about the supply of U.S. citizens for its ongoing mission.

G. Department of Energy (DOE). The Applied Mathematical Sciences program in the DOE Office of Energy Research serves two distinct roles. Mathematical sciences research is aimed at understanding models arising in DOE research and development programs and to provide supercomputing resources to DOE's researchers. Growth of these programs continued in 1989 and 1990. The applied mathematical sciences research program funds basic research in the national laboratories, universities, and private research institutions, in these categories: analytic and numerical methods, computational statistics, information analysis techniques, and advanced computing concepts for parallel architectures and languages. Topical areas of mathematics that are supported include: applied analysis, discrete mathematics, statistics and probability, linear algebra, optimization and control, geometry, dynamical systems, and nonlinear analysis.

Support for computer science and mathematics is split about evenly between U.S. universities and the DOE National Laboratories (which happen to be managed by universities in several cases). The dollar figures in this chapter reflect only the research support for the mathematical sciences. For computer science, see the appropriate chapter in the *AAAS Report XV*.

The table on the next page shows the budgets for the years between 1983 and 1991 for the federal agencies that have supported mathematical research. As before, we have updated some of the figures from prior years as better information has become available.

H. Other Federal Agencies. Several agencies, such as the National Aeronautics and Space Administration and the National Institutes of Health, support mathemat-

For Your Information

cal sciences programs, though mostly in-house. NASA also supports the Institute for Computer Applications in Science and Engineering in Langley, VA, with a budget of approximately \$1 million annually. The National

Institute of Standards and Technology, as well as numerous national laboratories in other federal agencies, conduct substantial in-house mathematics, statistics, and computer science research programs.

**FEDERAL AGENCY SUPPORT IN THE MATHEMATICAL SCIENCES
(IN MILLIONS OF DOLLARS), 1983 - 1991**

	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
NAT'L. SCIENCE FOUNDATION									
DMS	34.10	41.20	47.50	51.74	59.42	63.76	66.02	69.12	73.72
Other (1)	3.00	4.00	5.00	5.50	5.00	5.50	8.00	8.00	10.00
Total NSF	37.10	45.20	52.50	57.24	64.42	69.26	74.02	77.12	83.72
DEPT. OF DEFENSE (2)									
AFOSR	7.30	10.20	11.82	13.30	15.30	14.30	16.45	16.50	17.50
ARO	6.50	6.80	7.50	8.40	9.70	10.60	11.50	12.00	12.00
ONR	12.70	11.90	11.98	12.81	11.30	11.50	12.02	12.70	14.13
DARPA	*	*	1.00	5.50	9.20	12.00	12.00	12.00	12.00
NSA	*	1.02	1.32	1.62	1.90	2.31	2.86	3.20	3.20
Total DOD	26.50	29.92	33.62	41.63	47.40	50.71	54.83	56.40	58.83
DEPT. OF ENERGY (3)									
University Support	2.80	2.90	3.50	3.94	4.30	5.90	5.70	6.40	6.50
Nat'l. Laboratories	3.90	4.30	5.10	5.80	5.50	5.90	6.50	6.50	7.00
Total DOE	6.70	7.20	8.60	9.74	9.80	11.80	12.20	12.90	13.50
OTHER AGENCIES									
	2.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00
TOTAL NON-NSF	35.20	39.12	44.22	53.37	58.20	63.51	68.03	70.30	73.33
GRAND TOTAL-All Agencies	72.30	84.32	96.72	110.61	122.62	132.77	142.05	147.42	157.05

(1) Includes estimates for S/T Centers after FY 1988

(2) Some DOD programs include University Research Initiatives (URI)

(3) The DOE Mathematical Sciences Program also supports computer science programs at about the same level

1990 AMS Elections

Council Nominations **Vice-President, Trustee and Members-at-Large**

One vice-president, one trustee and five members-at-large of the Council will be elected by the Society in a contested election in the fall of 1990.

The vice-president will serve for a term of two years effective January 1, 1991. The Council has nominated two candidates for the position, namely:

Chandler Davis

Hans F. Weinberger

The trustee will serve for a term of five years effective January 1, 1991. The Council has nominated two candidates for the position, namely:

Jane Gilman

M. Susan Montgomery

The five members-at-large will serve for a term of three years. The Council nominated seven candidates. They are:

David A. Cox

Lesley M. Sibner

John M. Franks

Ruth J. Williams

Kunio Murasugi

Lai-Sang Young

Donald St. P. Richards

If nominations by petition have not appeared bringing the total number of candidates to at least ten, it will be brought up to ten by the Council.

The deadline for petitions is July 6. Such proposals will not reach the Council for action until the August Council meeting.

President's Candidates **Nominating Committee**

Three members of the Nominating Committee are to be elected in the fall of 1990 to serve for a term of three years.

Continuing members are:

Joan S. Birman

James E. Humphreys

Barbara Lee Keyfitz

Victor Klee

Ray A. Kunze

Alan D. Weinstein

Robert Williams

President William Browder has named six candidates for the other three places. They are:

Michael Aschbacher

Jerry Lawrence Kazdan

Eric D. Bedford

Walter D. Neumann

Henri Gillet

Stephen Wainger

Additional candidates may be nominated by petition, deadline for which is July 6.

Editorial Boards Committee

Two members of the Editorial Boards Committee are to be elected in the fall of 1990 to serve for a term of three years.

Continuing members are:

Linda Keen

Barry Simon

Carlos Kenig

Daniel Zelinsky

President William Browder has named four candidates for the other two places. They are:

Jon F. Carlson

Stephen S. Shatz

Richard J. Milgram

Nolan R. Wallach

Additional candidates may be nominated by petition, deadline for which is July 6.

Robert M. Fossum
Secretary
Urbana, Illinois

Columbus Meetings

August 8 - 11, 1990

Preliminary Program

The preliminary program for the Columbus Meetings follows. Participants who preregistered by June 6 and who so elected will have their badge and the final program mailed to them before the meetings. All other registrants will receive the final program at the meetings. Participants who have not yet registered should read the information in the April and May/June issues of *Notices* and the April issue of *Focus* for further details. The additional information below is to assist those who will register at the meetings and those preregistrants who elected not to receive their badge and final program by mail.

Registration at the Meetings

Meeting preregistration and registration fees only partially cover expenses of holding meetings. All mathematicians who wish to attend sessions are expected to register, and should be prepared to show their meeting badge, if so requested. Badges are required to obtain discounts at the AMS and MAA Book Sales and to cash a check with the meeting cashier. If a preregistrant should arrive too late in the day to pick up his/her badge, he/she may show the acknowledgement received from the Mathematics Meetings Housing Bureau as proof of registration.

Registration fees: Registration fees may be paid at the meetings in cash, by personal or travelers' check, or by Visa or MasterCard credit card. Canadian checks must be marked for payment in U.S. funds. Although other credit cards are being accepted by hotels for housing payments, only Visa or MasterCard can be accepted for registration. Letters verifying attendance at the meetings can be obtained from the cashier or at the Registration Assistance section of the registration desk.

Participants wishing to attend sessions for one day only may take advantage of a one-day fee which is equal to 55% of the on-site registration fee for either members or nonmembers. These special fees are effective daily August 8 through 11, and are available at the meetings to members and nonmembers only. These one-day fees are not applicable to student, unemployed, or emeritus

participants, whose fees for registration at the meetings are listed below.

Joint Mathematics Meetings

Member of AMS, Canadian Mathematical Society, MAA, IIME	\$ 93
Emeritus Member of AMS, MAA	\$ 32
Nonmember	\$141
Student/Unemployed	\$ 32

Joint Mathematics Meetings One Day

Member of AMS, CMS, MAA	\$ 51
Nonmember	\$ 78

AMS Short Course

Student/Unemployed	\$ 20
Member/Nonmember	\$ 50
Emeritus Member of AMS, MAA	\$ 20

MAA Minicourses

(if openings available)

Minicourses # 1, 2, 3, 5, 6, 8	\$ 36
Minicourses #4, 7, 9, 10, 11, 13	\$ 60
Minicourse #12	\$ 18

There is no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

All **full-time** students currently working toward a degree or diploma qualify for the student registration fees, regardless of income.

The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include any person who has voluntarily resigned or retired from his or her latest position.

Persons who qualify for emeritus membership in either the Society or the Association may register at the emeritus member rate. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more, and is retired on account of age or on account of long term disability from his or her latest position.

Nonmembers who preregister or register at the meeting and pay the nonmember fee will receive mailings from AMS and MAA, after the meeting is over, containing information about a special membership offer.

An income tax deduction is allowed for education expenses, including registration fees, cost of travel, meals and lodging incurred to (i) maintain or improve skills in one's employment or trade or business or (ii) meet express requirements of an employer or a law imposed as a condition to retention of employment, job status, or rate of compensation. This is true even for education that leads to a degree. However, the Tax Reform Act of 1986 has introduced significant changes to this area. In general, the deduction for meals is limited to 80% of the cost. Unreimbursed employee educational expenses are subject to a 2% of adjusted gross income floor. There are exceptions to these rules; therefore, one should contact one's tax advisor to determine the applicability of these provisions.

Registration Dates, Times, and Locations

AMS Short Course

Outside Conference Theatre, Ohio Union

Monday, August 6 8:30 a.m. to 2:30 p.m.

Joint Mathematics Meetings

[and MAA Minicourses (until filled)]

Main Lounge, Ohio Union

Tuesday, August 7 3:00 p.m. to 7:00 p.m.

Wednesday, August 8
through 7:30 a.m. to 4:00 p.m.

Friday, August 10

Saturday, August 11 7:30 a.m. to 1:00 p.m.

Directions to the Joint Mathematics Meetings Registration Desk: The Ohio Union is located at 1739 North High Street. Enter the building at the northeast entrance and take the stairs up to the Lobby. Go left at the newsstand, pass the art gallery on the right. The Main Lounge is on the left where the large stone fireplace is located.

Accommodations

Participants who did not reserve a room during preregistration and would like to reserve a room at one of the hotels listed on page 466 of the April issue of *Notices* and in *Focus* should call the hotels directly. All rooms and rates listed **are based on availability ONLY.**

Those participants who did not arrange for a room on campus but wish to be assigned a room onsite must go to the University Residential Office (URO) located in the ground floor lobby of Drackett Tower. The office is open 24 hours a day, seven days a week. Payments for rooms are due at check-in time and must be made at the URO. Payments at the URO may be made with cash, traveler's checks, personal checks, VISA or MasterCard. No other credit cards can be accepted. Rooms for walk-ins are limited and **are based on availability ONLY.**

Travel

Two major interstate highways make Columbus accessible by car. From the east or west, take Interstate 70; from the north or south, follow Interstate 71. The Outerbelt I-270 encircles the city and intersects both of the interstates. From the north, take the Outerbelt west and exit at 315 South. From the west, south, or east, follow route signs to 315 North. Travelling either north or south on 315, exit at Lane Avenue and travel east for approximately one mile to the Ohio State campus area.

Unless otherwise posted, it is legal to make a right turn on a red light after coming to a complete stop and signaling. It is also legal to make a left turn on a red light if turning from a one-way street onto another one-way street. Again, it is mandatory to come to a full stop and use a turn signal.

Updated driving directions from the Port Columbus Airport to the URO are as follows: Take a left on Steltzer Road. Take ramp onto Route 62. Get off on 5th Avenue West. Take a right on 4th Street North. Follow 4th Street North to 15th Avenue. Turn left to High Street. Turn right to Woodruff (two blocks). Turn left on Woodruff to Curl Drive. Follow Curl Drive to Drackett Tower. Directions to specific residence halls will be provided by the URO.

Preliminary Program of the Sessions

If available, abstracts of papers presented by the AMS-MAA lecturer, AMS Progress in Mathematics Lecturers, AMS invited 50-minute speakers, MAA Hedrick Lecturer, MAA invited speakers, MAA joint invited speakers, and speakers in other MAA sessions will be found in a colored insert in the program given to registrants. Abstracts of papers presented in AMS Special Sessions and AMS Sessions for Contributed Papers will be found in the August issue of *Abstracts of papers presented to the American Mathematical Society*, which will also be provided to registrants at the meeting, upon request. Abstracts for talks other than AMS and MAA are not available.

To maintain the schedule, beginning and ending times of presentations will be strictly enforced.

For papers with more than one author, an asterisk follows the name of the author who plans to present the paper at the meeting. Where a presenter is visiting another institution, the permanent affiliation is given first, followed by the name of the institution being visited.

Monday, August 6

AMS Short Course

9:00 a.m.–5:00 p.m.

- 9:00 a.m. *What is a game?*
 (1) **Richard K. Guy**, University of Calgary
 10:45 a.m. *Numbers and games.*
 (2) **John H. Conway**, Princeton University
 2:00 p.m. *Impartial games.*
 (3) **Richard K. Guy**, University of Calgary
 3:45 p.m. *More ways of combining games.*
 (4) **John H. Conway**, Princeton University

Tuesday, August 7

MAA Board of Governors

8:30 a.m.–4:00 p.m.

AMS Short Course

9:00 a.m.–5:00 p.m.

- 9:00 a.m. *Introductory overview of mathematical Go endgames.*
 (5) **Elwyn R. Berlekamp**, University of California, Berkeley
 10:45 a.m. *Games and codes.*
 (6) **Vera S. Pless**, University of Illinois, Chicago
 2:00 p.m. *Complexity of games.*
 (7) **Aviezri S. Fraenkel**, Weizmann Institute of Science, Israel
 3:45 p.m. ..., *Welter's Game, Sylver Coinage, Dots-and-Boxes, ...*
 (8) **Richard J. Nowakowski**, Dalhousie University

AMS Council

2:00 p.m.–7:00 p.m.

MAA Section Officers

4:00 p.m.–6:00 p.m.

Joint Policy Board for Mathematics: National Meetings of Department Heads

8:15 p.m.–10:00 p.m.

Curriculum reform—How does a department chair cause it to happen?.

Wednesday, August 8

Opening Ceremonies

8:30 a.m.–9:30 a.m.

MAA Invited Address

9:55 a.m.–10:45 a.m.

- (9) *The seventy-fifth anniversary celebration.*
G. Baley Price, University of Kansas

Plaque Ceremony

10:55 a.m.–11:00 a.m.

Wednesday, August 8 (cont'd)

MAA Invited Address

11:10 a.m.-noon

- (10) *Was Newton's calculus just a deadend?
Maclaurin and the Scottish connection.*
Judith V. Grabiner, Pitzer College, Scotland

MAA Invited Address

1:30 p.m.-2:00 p.m.

- (11) *Mathematics and computation: Proliferation and fragmentation.*
Wade Ellis, Jr., West Valley College

MAA Invited Address

✓ 2:10 p.m.-2:40 p.m.

- (12) *Has progress in mathematics slowed down?*
Paul R. Halmos, Santa Clara University

MAA Invited Address

2:50 p.m.-3:20 p.m.

- ✓ (13) *The contribution of mathematics to education.*
Peter J. Hilton, State University of New York, Binghamton

MAA Invited Address

3:30 p.m.-4:00 p.m.

- (14) *The last 75 years: Giants of applied mathematics.*
Cathleen S. Morawetz, Courant Institute of Mathematical Sciences, New York University

Mathematical Circus

4:45 p.m.-5:45 p.m.

Thursday, August 9

MAA Special Presentation

8:00 a.m.-8:30 a.m.

- (15) *Theorems in bronze and stone.*
Helaman Ferguson, Supercomputing Research Center, Bowie, Maryland

AMS Special Session on Combinatorics, I

8:00 a.m.-11:50 a.m.

- 8:00 a.m. *Voltage-current duality.*
(16) **Dan Archdeacon**, University of Vermont (859-05-129)
- 8:30 a.m. *Bounds on the distance-d domination number.*
(17) Preliminary report.
Joan P. Hutchinson, Macalester College (859-05-109)
- 9:00 a.m. *Subgraphs with crossing number 2.*
(18) **Dan McQuillan** and **R. B. Richter***, Carleton University (859-05-161)
- 9:30 a.m. *Graphs containing crossing number 2 graphs.*
(19) **Richard Vitray**, Appalachian State University (859-05-168)
- 10:00 a.m. *Ideal secret sharing schemes and matroids.*
(20) **Ernest F. Brickell*** and **Daniel M. Davenport**, Sandia National Laboratories (859-05-99)
- 10:30 a.m. *Howell designs with sub-designs.* Preliminary report.
(21) **J. H. Dinitz***, University of Vermont, and **E. R. Lamken**, Institute for Defense Analyses (859-05-149)
- 11:00 a.m. *Mappings of sets of pairwise orthogonal orthomorphisms.* Preliminary report.
(22) **Robert Roth**, Emory University (859-05-82)
(Sponsored by Dwijendra K. Ray-Chaudhuri)
- 11:30 a.m. *Singularity probabilities for random $\{\pm\}$ -matrices.*
(23) **Jeff Kahn***, **János Komlós** and **Endre Szemerédi**, Rutgers University, New Brunswick (859-05-84)

AMS Special Session on Algebraic Geometry, I

8:00 a.m.-9:50 a.m.

- 8:00 a.m. *Valuations and convergence of formal functions.*
(24) Preliminary report.
Mark Spivakovsky, Harvard University (859-13-67)
- 8:30 a.m. *Weak CMC subsets and orderings of fields.*
(25) **Marie A. Vitulli**, University of Oregon (859-13-108)

Preliminary Program of the Sessions

- 9:00 a.m. *Jet bundles and curves in Grassmannians.*
(26) **David Perkinson**, Reed College (859-14-120)
- 9:30 a.m. *Automorphisms of cuspidal K3-like surfaces in low characteristics.*
(27) **Brian Harbourne**, University of Nebraska, Lincoln (859-14-77)

MAA Minicourse #1: Part A

8:00 a.m.–10:00 a.m.

Using metacognitive strategies to improve instruction.
Genevieve Knight, Coppin State College

MAA Minicourse #2: Part A

8:00 a.m.–10:00 a.m.

Planning, funding, and administering teacher enhancement projects. **T. Christine Stevens**, St. Louis University

MAA CUPM Subcommittee on Symbolic Computer Systems Poster Session

8:00 a.m.–noon

What students learn in the symbolic computing environment.

MAA Session on The Interface Between Mathematics and Operations Research, Part A

8:05 a.m.–noon

- 8:05 a.m. *Operations research in the shipping industry.*
(28) **Ken Bloom**, Stolt-Nielsen Inc., Greenwich, Connecticut
- 9:15 a.m. *Operations research at the United States Coast Guard Academy.*
(29) **Ted Lindstrom*** and **Ernest J. Manfred**, United States Coast Guard Academy
- 9:40 a.m. *Optimization: The world as a system of equations.*
(30) **Patrick T. Harker**, University of Pennsylvania
- 10:05 a.m. *An improved counterexample to the rudimentary primal algorithm.*
(31) **Robert Haas***, **Harvey M. Salkin** and **Kamlesh Mathur**, Case Western Reserve University
- 10:30 a.m. *Waiting in line: The mathematics of queuing.*
(32) **Karen J. Schroeder**, Bentley College
- 11:00 a.m. *Modeling and analysis of telecommunications systems.*
(33) **Shlomo Halfin**, Bell Communications Research Inc., Morristown, New Jersey

AMS Special Session on Dynamics of Biological Systems, I

8:30 a.m.–11:50 a.m.

- 8:30 a.m. *The transition from bursting to continuous spiking in a model for excitable membranes.*
(34) **David Terman**, Ohio State University, Columbus (859-92-85)
- 9:00 a.m. *An "averaged" model for parabolic bursting oscillations.*
(35) **John Rinzel***, National Institute of Health, **Humberto Carrillo-Calvet**, Universidad Nacional Autonoma de Mexico, and **Steven M. Baer**, Arizona State University (859-92-56)
- 9:30 a.m. *A geometric description of echo.*
(36) **G. Bard Ermentrout***, University of Pittsburgh, Pittsburgh, and **John Rinzel**, National Institute of Health (859-92-92)
- 10:00 a.m. *Travelling wave solutions for a bistable evolutionary ecology model.*
(37) **Roger Lui**, Worcester Polytechnic Institute (859-35-71)
- 10:30 a.m. *Existence of travelling wave solutions for reaction diffusion systems.*
(38) **Konstantin M. Mischaikow**, Georgia Institute of Technology (859-35-144)
- 11:00 a.m. *The existence of infinitely many traveling front and back waves in the FitzHugh-Nagumo equations.*
(39) **Bo Deng**, University of Nebraska, Lincoln (859-35-105)
- 11:30 a.m. Discussion

MAA-AAAS Invited Address

8:50 a.m.–9:40 a.m.

- (40) *Lost and found mathematics.*
Richard A. Askey, University of Wisconsin, Madison

MAA CUPM Subcommittee on Quantitative Literacy Requirements Panel Discussion

8:50 a.m.–9:40 a.m.

Quantitative literacy.

AMS Special Session on Ring Theory, I

9:00 a.m.–11:50 a.m.

- 9:00 a.m. *The κ -product of slender modules.* Preliminary report.
(41) **John Dauns*** and **Laszlo Fuchs**, Tulane University (859-16-57)

Thursday, August 9 (cont'd)

- 9:30 a.m. *Finitely generated non-cosmall modules.*
(42) Preliminary report.
Stanley S. Page, University of British Columbia
(859-16-72)
- 10:00 a.m. Intermission
- 11:00 a.m. *Permutation identity rings.*
(43) **Gary F. Birkenmeier*** and **Henry Heatherly**,
University of Southwestern Louisiana
(859-16-26)
- 11:30 a.m. *Distributive modules which are cyclic.*
(44) **Vahap Erdogdu**, Middle East Technical
University, Turkey (859-13-08) (Sponsored by
Hursit M. Onsiper)

AMS Special Session on Group Theory, I

9:00 a.m.–11:50 a.m.

- 9:00 a.m. *Isomorphy problem of integral group rings.*
(45) **Hans J. Zassenhaus**, Ohio State University,
Columbus (859-20-45)
- 9:30 a.m. *A conjecture on character degrees.* Preliminary
(46) report.
Michael J. J. Barry, Allegheny College
(859-20-22)
- 10:00 a.m. *k-characters and the group determinant.*
(47) Preliminary report.
Kenneth W. Johnson, Pennsylvania State
University, Ogotz and Iowa State University
(859-20-13)
- 10:30 a.m. *Infinite Frobenius groups.*
(48) **Michael J. Collins**, Mathematical Institute,
England (859-20-36) (Sponsored by Ronald M.
Solomon)
- 11:00 a.m. *Powers of varieties and faithful representations*
(49) *of groups.* Preliminary report.
Samuel M. Vovsi, Rutgers University, New
Brunswick (859-20-17)
- 11:30 a.m. *The integral group ring problem.*
(50) **Leonard L. Scott, Jr.**, University of Virginia
(859-20-37)

MAA Student Chapter Panel Discussion

9:00 a.m.–10:30 a.m.

AWM Panel Discussion

9:00 a.m.–10:00 a.m.

Enrichment programs in urban public schools.

AMS-MAA Invited Address

9:55 a.m.–10:45 a.m.

- (51) *Algebra as a means of understanding
mathematics.*
Saunders Mac Lane, University of Chicago

AWM Membership Meeting & Prize Session

10:00 a.m.–10:45 a.m.

MAA Minicourse #3: Part A

10:15 a.m.–12:15 p.m.

A seminar on women in mathematics. **Miriam P. Cooney csc**,
St. Mary's College

MAA Minicourse #4: Part A

10:15 a.m.–12:15 p.m.

A calculus laboratory using Mathematica. **Michael Barry**,
Benjamin Haytock and **Richard McDermot**, Allegheny
College

MAA Minicourse #5: Part A

10:15 a.m.–12:15 p.m.

Using history in teaching calculus. **V. Frederick Rickey**,
United States Military Academy

MAA-NCTM Invited Address

11:00 a.m.–11:50 a.m.

- (52) *Mathematics education-yesterday, today, and
tomorrow.*
John A. Dossey, Illinois State University

National Science Foundation

noon–1:00 p.m.

MAA Earle Raymond Hedrick Lectures: Lecture I

1:15 p.m.–2:15 p.m.

- (53) *Spirals from Theodorus of Cyrene to
meta-chaos. Spirals old and new.*
Philip J. Davis, Brown University

Preliminary Program of the Sessions

MAA-PME Invited Address

2:30 p.m.-3:20 p.m.

- (54) *Problems for all seasons.*
Ivan Niven, University of Oregon

MAA Minicourse #1: Part B

2:30 p.m.-4:30 p.m.

Using metacognitive strategies to improve instruction.
Genevieve Knight, Coppin State College

MAA Minicourse #2: Part B

2:30 p.m.-4:30 p.m.

Planning, funding, and administering teacher enhancement projects. T. Christine Stevens, St. Louis University

MAA Session on Toward Equity and Excellence:
Efforts to Increase the Number of
Minorities and Women in the Profession

2:30 p.m.-5:20 p.m.

- 2:30 p.m. *MathConn 89 and MathConn 90: Two successful mathematics awareness days for seventh and eighth grade girls and their teachers.*
(55) Regina Baron Brunner, Cedar Crest College, Pennsylvania
- 3:00 p.m. *Encouraging women and older students in mathematics: A math anxiety reduction program.*
(56) Antonella Cupillari, Pennsylvania State University, Erie-Behrend College
- 3:30 p.m. *Multi-cultural factors in mathematics education.*
(57) Barbara S. Rice, Alabama A & M University
- 4:00 p.m. *NCI summer enrichment program.*
(58) Gloria F. Gilmer, Math-Tech Inc., Milwaukee, Wisconsin
- 4:30 p.m. *The efforts of a few can help the many.*
(59) Sherrie J. Nicol, University of Wisconsin, Platteville
- 5:00 p.m. *A family of equity programs.*
(60) Claudia L. Pinter-Lucke, California Polytechnic State University

MAA Session on The Interface Between
Mathematics and Operations Research, Part B

2:30 p.m.-5:20 p.m.

- 2:30 p.m. *Modeling performance in emergency vehicle systems: A link between mathematics and operations research.*
(61) Jeff Goldberg, University of Arizona
- 3:40 p.m. *Using synergism to generate new classroom applications of mathematics.*
(62) Miguel Paredes, University of Texas-Pan American
- 4:05 p.m. *What mathematics teaches the simulationist, and vice versa.*
(63) Diane Driscoll Schwartz, Ithaca College
- 4:30 p.m. *Four counterexamples to heuristic algorithms for the traveling salesman problem.*
(64) Robert Haas, Harvey M. Salkin* and Kamlesh Mathur, Case Western Reserve University
- 5:00 p.m. *Movie: Operations research + you = an exciting career.*

MAA CUPM Subcommittee on Symbolic
Computer Systems Panel Discussion

2:30 p.m.-4:00 p.m.

The pedagogical impact of computer algebra systems on college mathematics curricula.

PME Contributed Paper Session

3:30 p.m.-5:30 p.m.

AMS Progress in Mathematics Lecture

3:35 p.m.-5:05 p.m.

- (65) *Viscosity solutions of partial differential equations.*
Michael G. Crandall, University of California, Santa Barbara (859-35-169)

MAA Special Lecture

4:30 p.m.-5:20 p.m.

- (66) *The art of mental calculation.*
Arthur T. Benjamin, Harvey Mudd College

Thursday, August 9 (cont'd)

MAA CUPM Subcommittee on Symbolic Computer Systems Special Presentation

4:30 p.m.-5:20 p.m.

Symbolic computing in undergraduate mathematics: Symbols, pictures, numbers, and insights.

MAA Minicourse #3: Part B

4:45 p.m.-6:45 p.m.

A seminar on women in mathematics. **Miriam P. Cooney csc**, Saint Mary's College

MAA Minicourse #4: Part B

4:45 p.m.-6:45 p.m.

A calculus laboratory using Mathematica. **Michael Barry, Benjamin Haytock and Richard McDermot**, Allegheny College

MAA Minicourse #5: Part B

4:45 p.m.-6:45 p.m.

Using history in teaching calculus. **V. Frederick Rickey**, United States Military Academy

AMS-MAA-MSEB Evening of Dialogue

7:30 p.m.-9:00 p.m.

Mathematics education.

PME J. Sutherland Frame Lecture

8:30 p.m.-9:30 p.m.

(67) *Combinatorics and computers: Coping with finiteness.*
Ronald L. Graham, AT&T Bell Laboratories, Murray Hill, New Jersey

Friday, August 10

AMS Special Session on Combinatorial Games

8:00 a.m.-10:50 a.m.

8:00 a.m. *Dots and boxes.*

(68) **R. J. Nowakowski**, Dalhousie University (859-05-136) (Sponsored by Richard K. Guy)

8:30 a.m. *On the cookie game.*

(69) **James Propp** and **Daniel Ullman***, George Washington University (859-05-137)

9:00 a.m. *Nimdi games.*

(70) **U. Blass, A. S. Fraenkel*** and **M. Lorberbom**, Weizmann Institute of Science, Israel (859-05-73)

9:30 a.m. *Invading corridors of territory in Go.*

(71) **Elwyn Berlekamp** and **David Wolfe***, University of California, Berkeley (859-90-145)

10:00 a.m. *Classical partisan theory extended to loopy games.*

(72) **Elwyn Berlekamp**, University of California, Berkeley (859-05-138)

10:30 a.m. *Mathematical Kayles.*

(73) **William L. Sibert**, Stanford, Connecticut, and **John H. Conway***, Princeton University (859-90-122) (Sponsored by Richard K. Guy)

AMS Special Session on Group Theory, II

8:00 a.m.-10:50 a.m.

8:00 a.m. *Strongly p -embedded subgroups of finite simple groups.*

(74) **Daniel Gorenstein***, **Richard Lyons**, Rutgers University, New Brunswick, and **Ronald Solomon**, Ohio State University, Columbus (859-20-39)

8:30 a.m. *The maximal subgroups of the Chevalley groups of type $F_4(F)$, $\text{char}(F) \neq 2, 3$.*

(75) **Kay Magaard**, California Institute of Technology (859-20-16)

9:00 a.m. *On the influence of maximal subgroups on the structure of a finite group: Some new results.*

(76) **Prabir Bhattacharya***, University of Nebraska, Lincoln, and **N. P. Mukherjee**, Jawaharlal Nehru University, India (859-20-18)

9:30 a.m. *The Schur index of projective characters of symmetric and alternating groups.*

(77) **Alexandre Turull**, University of Miami (859-20-15)

10:00 a.m. *The representation theory of fully group-graded algebras.*

(78) **Paul Boisen**, University of Chicago (859-20-69)

Preliminary Program of the Sessions

- 10:30 a.m. *On a combinatorial problem associated with the odd order theorem.*
(79) **George Glauberman***, University of Chicago, and **Simon P. Norton**, University of Cambridge, England (859-20-33)

AMS Session on Graph Theory and Combinatorics

8:00 a.m.-10:10 a.m.

- 8:00 a.m. *The multi-intersection number of a graph.*
(80) **Frank Harary**, New Mexico State University, Las Cruces (859-05-59)
- 8:15 a.m. *A problem of degrees in graphs.*
(81) **Lisa Hansen** and **Michelle Schultz***, Western Michigan University (859-05-133)
- 8:30 a.m. *Subgraph distance in graphs.*
(82) **Gary Chartrand***, Western Michigan University, **Garry Johns**, Saginaw Valley State University, **Karen S. Novotny**, Grand Valley State University, and **Ortrud R. Oellermann**, University of Natal, Republic of South Africa (859-05-131)
- 8:45 a.m. *Clique representations of chordal-like graphs.*
(83) Preliminary report.
Charles Carraher* and **Terry McKee**, Wright State University (859-05-75)
- 9:00 a.m. *Planarity of n -subgraph distance graphs.*
(84) **Gary Chartrand**, **Héctor Hevia**, **Elzbieta B. Jarrett***, Western Michigan University, and **Donald W. Vanderjagt**, Grand Valley State University (859-05-132)
- 9:15 a.m. *A different algorithm for the detection of 3-manifolds.*
(85) **John Emert***, Ball State University, and **Lawrence Husch**, University of Tennessee, Knoxville (859-05-125)
- 9:30 a.m. *Routings for involutions of a hypercube.*
(86) **Alan P. Sprague***, University of Alabama, Birmingham, and **Hisao Tamaki**, Ibaraki University, Japan (859-05-97)
- 9:45 a.m. *Smallest tournaments with given abelian automorphism group.*
(87) **William C. Arlinghaus**, Lawrence Technical University (859-05-117)
- 10:00 a.m. *A combinatorial approach to temporal reasoning.*
(88) **Alexander Belfer**, Bar-Ilan University, Israel, and **Martin Charles Golumbic***, IBM Israel Scientific Center, Israel (859-05-34)

MAA Session

8:00 a.m.-9:30 a.m.

Modeling.

AMS Session on Geometry, Topology and Infinite Combinatorics

8:20 a.m.-10:45 a.m.

- 8:20 a.m. *The p -torsion of the Farrell-Tate cohomology of the mapping class group $\Gamma_{g-1}/2$.* Preliminary report.
(89) **Yining Xia**, Ohio State University, Columbus (859-55-158)
- 8:35 a.m. *Minimal surfaces satisfying the spherical Ricci condition.*
(90) **Gene Douglas Johnson**, Franklin & Marshall College (859-53-155)
- 8:50 a.m. *On a conjecture of Nitsche.*
(91) **Gregory D. Crow**, John Carroll University (859-53-52)
- 9:05 a.m. *Consequences of the lattice pentagon property.*
(92) **Stanley Rabinowitz**, Westford, Massachusetts (859-52-142)
- 9:20 a.m. *Euclidean hypersurfaces with reflection properties.* Preliminary report.
(93) **Daniel Drucker**, Wayne State University (859-53-106)
- 9:35 a.m. *Lattice realcompactifications.* Preliminary report.
(94) **James Camacho, Jr.**, Jersey City State College (859-28-143)
- 9:50 a.m. *A note on minimal cover refinable spaces.* Preliminary report.
(95) **Gangadhar Hiremath**, Talladega College (859-54-95)
- 10:05 a.m. *Connectedness of self-similar sets.* Preliminary report.
(96) **Gary Lewellen**, Appalachian State University (859-54-51)
- 10:20 a.m. *Non-homeomorphic disjoint spaces whose union is ω^* .*
(97) **W. W. Comfort***, Wesleyan University, and **Akio Kato**, National Defense Academy, Japan (859-54-111)
- 10:35 a.m. *Measurable cardinals and category bases.*
(98) **Andrzej Szymanski**, Slippery Rock University of Pennsylvania (859-04-49)

AMS Special Session on Dynamics of Biological Systems, II

8:30 a.m.-10:50 a.m.

- 8:30 a.m. *Resonance and phase-locking in excitable systems.*
(99) **Hans G. Othmer**, University of Utah (859-92-153)

Friday, August 10 (cont'd)

- 9:00 a.m. (100) *Computer simulations of excitation in an anatomically based model of the ventricular conduction system.*
Andrew E. Pollard, Nora Eccles Harrison Cardiovascular Research and Training Institute, University of Utah (859-92-86) (Sponsored by David Terman)
- 9:30 a.m. (101) *A dynamical systems analysis of a population genetics model of learning.*
Steven R. Dunbar, University of Nebraska, Lincoln (859-92-123)
- 10:00 a.m. (102) *Applications of the stability index.*
Robert Gardner, University of Massachusetts, Amherst (859-35-68)
- 10:30 a.m. (103) *Travelling waves in fast/slow systems.*
 Preliminary report.
Christopher Jones*, University of Maryland, College Park, and **Nancy Kopell**, Boston University (859-34-128)

MAA Minicourse #6: Part A

8:30 a.m.-10:30 a.m.

Writing to learn mathematics. **Agnes Azzolino**, Middlesex County College

MAA Minicourse #7: Part A

8:30 a.m.-10:30 a.m.

Exploring mathematics with the NeXT computer. **Charles G. Fleming** and **Judy D. Halchin**, Eastern Illinois University

MAA Minicourse #8: Part A

8:30 a.m.-10:30 a.m.

A mathematician's introduction to the HP-48SX scientific expandable calculator for first-time users. **Don LaTorre** and **John Kenelly**, Clemson University

MAA Minicourse #9: Part A

8:30 a.m.-10:30 a.m.

Starting, funding and sustaining mathematics laboratories.
James E. White, Kenyon College

MAA Session on Liberal Arts Mathematics Courses, Part A

8:30 a.m.-10:55 a.m.

- 8:30 a.m. (104) *Using elementary modeling with graphs and networks as the basis of a liberal arts mathematics course.*
Helen Christensen, Loyola College, Maryland
- 8:45 a.m. (105) *A course in graph modeling for liberal arts students.*
Anne E. Brown, Saint Mary's College, Indiana
- 9:00 a.m. (106) *A course in the theory of voting.*
Roger B. Nelsen, Lewis & Clark College
- 9:15 a.m. (107) *An accessible combinatorics module for liberal arts students.*
Emelie Kenney, Siena College, New York
- 9:30 a.m. (108) *Customized student papers in liberal arts mathematics.*
Robert Bumcrot, Hofstra University
- 9:45 a.m. (109) *Probability and calculus in a liberal arts mathematics course.*
Kay Gura* and **Giovanni Viglino**, Ramapo College of New Jersey
- 10:00 a.m. (110) *Using cooperative learning with oral protocols in mathematics for liberal arts students.*
G. Joseph Wimbish, Huntingdon College and University of Alabama
- 10:15 a.m. (111) *Optimization without calculus.*
James W. Petticrew, University of Texas-Pan American
- 10:30 a.m. (112) *How mathematics grows.*
Jerry D. Taylor, Campbell University
- 10:45 a.m. (113) *A tour in knot theory.*
Stefanos Gialamas, Columbia College, Chicago

AMS Invited Address

8:50 a.m.-9:40 a.m.

- (114) *The role of microlocal analysis in PDE.*
Michael E. Taylor, University of North Carolina, Chapel Hill (859-35-100)

MAA Committee on the Teaching of Undergraduate Mathematics Panel Discussion

9:00 a.m.-10:50 a.m.

Research in learning undergraduate mathematics.

Preliminary Program of the Sessions

MAA Committee on Computers in
Mathematics Education Panel Discussion

9:00 a.m.-10:50 a.m.

Visualization project.

PME Contributed Paper Session

9:15 a.m.-10:50 a.m.

AMS Invited Address

9:55 a.m.-10:45 a.m.

- (115) *Statistical mechanics of Coulomb systems.*
Joseph G. Conlon, University of Michigan, Ann Arbor (859-82-101)

AMS Prize Session and Business Meeting

11:05 a.m.-noon 0

National Science Foundation

noon-1:00 p.m.

PME Council

12:15 p.m.-1:15 p.m.

MAA Earle Raymond
Hedrick Lectures: Lecture II

1:15 p.m.-2:15 p.m.

- (116) *Spirals from Theodorus of Cyrene to meta-chaos. Lessons from Euler.*
Philip J. Davis, Brown University

MAA-CMS Invited Address

2:30 p.m.-3:20 p.m.

- (117) *Prime number records.*
Paulo Ribenboim, Queen's University

AMS Special Session on Combinatorics, II

2:30 p.m.-4:50 p.m.

- 2:30 p.m. *Graphs, games and structure theorems.*
(118) Neil Robertson, Ohio State University, Columbus, P. D. Seymour, Bellcore, Morristown, New Jersey, and Robin Thomas*, Georgia Institute of Technology (859-05-165)
- 3:00 p.m. *Supereulerian and collapsible graphs.*
(119) Paul A. Catlin, Wayne State University (859-05-151) (Sponsored by Jingyal Pak)
- 3:30 p.m. *A characterization in \mathbb{Z}^n of unit-distance graphs in \mathbb{R}^n .*
(120) Kiran B. Chilakamarri, Ohio State University, Columbus (859-05-146)
- 4:00 p.m. *Loop transversals to linear codes. Preliminary report.*
(121) Jonathan D. H. Smith, Iowa State University (859-05-23) (Sponsored by Dwijendra K. Ray-Chaudhuri)
- 4:30 p.m. *Large sets of disjoint t-designs.*
(122) Yeow Meng Chee, Charles J. Colbourn, Steven C. Furino, University of Waterloo, and Donald L. Kreher*, University of Wyoming (859-05-80)

AMS Special Session on Algebraic Geometry, II

2:30 p.m.-4:20 p.m.

- 2:30 p.m. *Canonical resolution of hypersurface singularities of characteristic p.*
(123) T. T. Moh, Purdue University, West Lafayette (859-13-141)
- 3:00 p.m. *Whose theorem is this?*
(124) Bruce Reznick, University of Illinois, Urbana-Champaign (859-14-98)
- 3:30 p.m. *Topology of Milnor fibers of minimally elliptic singularities. Preliminary report.*
(125) Lee J. McEwan, Ohio State University, Mansfield (859-14-130) (Sponsored by Gary P. Kennedy)
- 4:00 p.m. *Seemple's bundles of higher-order data. Preliminary report.*
(126) Susan Jane Colley and Gary Kennedy*, Oberlin College (859-14-102)

AMS Special Session on Ring Theory, II

2:30 p.m.-4:50 p.m.

- 2:30 p.m. *Primitive ideals in enveloping algebras of classical simple Lie superalgebras.*
(127) Ian M. Musson, University of Wisconsin, Milwaukee (859-16-58)

Friday, August 10 (cont'd)

- 3:00 p.m. *The algebraic structure of linearly recursive sequences under Hadamard product.*
(128) **Richard G. Larson**, University of Illinois, Chicago, and **Earl J. Taft***, Rutgers University, New Brunswick (859-16-05)
- 3:30 p.m. *Classical localization in a Morita context.*
(129) **Philippe Loustau** and **Jay Shapiro***, George Mason University (859-16-61)
- 4:00 p.m. *Value groups and distributivity.*
(130) **Hans H. Brungs***, University of Alberta, and **Joachim Gräter**, Technische Universität, Germany (859-16-63)
- 4:30 p.m. *Idempotents in matrix rings.* Preliminary report.
(131) **Christopher Barnett**, Imperial College of Science & Technology, England, and **Victor Camillo***, University of Iowa (859-16-28)

MAA Minicourse #6: Part B

2:30 p.m.–4:30 p.m.

Writing to learn mathematics. **Agnes Azzolino**, Middlesex County College

MAA Minicourse #7: Part B

2:30 p.m.–4:30 p.m.

Exploring mathematics with the NeXT computer. **Charles G. Fleming** and **Judy D. Halchin**, Eastern Illinois University

MAA Minicourse #9: Part B

2:30 p.m.–4:30 p.m.

Starting, funding and sustaining mathematics laboratories. **James E. White**, Kenyon College

AMS Session on Group Theory

2:30 p.m.–4:25 p.m.

- 2:30 p.m. *On automatic groups.*
(132) **Kazem Mahdavi**, State University of New York, College at Potsdam (859-20-42)
- 2:45 p.m. *On the integral cohomology of split metacyclic groups.* Preliminary report.
(133) **Dean Larson**, Gonzaga University (859-20-127)

- 3:00 p.m. *Finite groups having chain difference one.*
(134) Preliminary report.
Ben Brewster, State University of New York, Binghamton, **Michael B. Ward***, Bucknell University, and **Irene Zimmermann**, Freiburg, Germany (859-20-74)
- 3:15 p.m. *Metabelian groups with all cyclic subgroups subnormal of bounded defect.* Preliminary report.
(135) **David J. Garrison**, IBM Corporation, Owego, New York (859-20-66)
- 3:30 p.m. *Thin bases for finite groups.*
(136) **Xing-De Jia**, Graduate School and University Center, City University of New York (859-20-88)
- 3:45 p.m. *Some characters of twisted wreath products.*
(137) **George F. Yeh**, State University of New York, Binghamton (859-20-103)
- 4:00 p.m. *On exponential groups.*
(138) **Patrick B. Chen***, John Carroll University, and **Ta-Sun Wu**, Case Western Reserve University (859-22-152)
- 4:15 p.m. *A special class of finite p -groups.* Preliminary report.
(139) **Matthew P. Fisher**, State University of New York, Binghamton (859-20-166)

MAA Session on Liberal Arts Mathematics Courses, Part B

2:30 p.m.–4:40 p.m.

- 2:30 p.m. *Mathematical tools for critical thinking: A liberal arts mathematics course.*
(140) **Curtis McKnight**, University of Oklahoma
- 2:45 p.m. *Mathematics and the modern world: Core curriculum mathematics at a large public university.*
(141) **Richard Mercer**, Wright State University
- 3:00 p.m. *Developing students' mathematical power in liberal arts mathematics courses.*
(142) **Roger H. Marty**, Cleveland State University
- 3:15 p.m. *Mathematics for sensible living: Making connections with the adult world.*
(143) **Constance M. Elson**, Ithaca College
- 3:30 p.m. *"What is mathematics?" Is this the question for liberal arts students?*
(144) **Bruce Williamson**, University of Wisconsin, River Falls
- 3:45 p.m. *Reading and writing in a mathematical ideas course.*
(145) **Richard Alan Gillman**, Valparaiso University
- 4:00 p.m. *Can students in core requirement courses do mathematics on a creative level?*
(146) **Rhonda L. Hatcher**, Saint Olaf College
- 4:15 p.m. *A survey approach to liberal arts mathematics.*
(147) **Dan Kalman**, Rancho Palos Verdes, California

Preliminary Program of the Sessions

- 4:30 p.m. *Symmetry: Unifying abstraction, intuition and applications in a liberal arts mathematics course.*
(148)

Thomas Q. Sibley, Saint John's University,
Minnesota

PME Contributed Paper Session

2:30 p.m.–4:50 p.m.

MAA-SIAM Invited Address

3:35 p.m.–4:25 p.m.

- (149) *Interior point methods for linear programming: An overview.*

Richard A. Tapia, Rice University

MAA Open Discussion on Consultants

3:50 p.m.–4:50 p.m.

MAA Prize Session and Business Meeting

5:05 p.m.–6:00 p.m.

AMS Committee on Science
Policy Panel Discussion

8:00 p.m.–10:00 p.m.

Responsibilities of mathematicians in the implementation of the DAVID II Report.

Saturday, August 11

AMS Special Session on Combinatorics, III

8:00 a.m.–11:50 a.m.

- 8:00 a.m. *Delsarte's inequalities and t -designs.*
(150)

Richard M. Wilson, California Institute of
Technology (859-05-154) (Sponsored by
Dwijendra K. Ray-Chaudhuri)

- 8:30 a.m. *Association schemes on triples and a ternary algebra.*
(151)

Dale M. Mesner and **Prabir Bhattacharya***,
University of Nebraska, Lincoln (859-05-19)

- 9:00 a.m. *Cycle ideals and tactical partitions of distance-regular graphs.*
(152)

Aaron D. Meyerowitz, Florida Atlantic
University (859-05-119)

- 9:30 a.m. *A large set of designs on vector spaces.*
(153)

D. K. Ray-Chaudhuri and **Erin J. Schram***,
Ohio State University, Columbus (859-05-79)

- 10:00 a.m. *Structure theory of planar graphs embedded on nonplanar surfaces.* Preliminary report.
(154)

Bojan Mohar, University of Ljubljana,
Yugoslavia, **Neil Robertson***, Ohio State
University, Columbus, and **Richard Vitray**,
Appalachian State University (859-05-147)

- 10:30 a.m. *Leafless trees in countable graphs.* Preliminary report.
(155)

Bogdan Oporowski, Louisiana State
University, Baton Rouge (859-05-162)

- 11:00 a.m. *Incidence matrices in geometric lattices.*
(156)

Joseph P. S. Kung, University of North Texas
(859-05-35)

- 11:30 a.m. *Strong Tutte functions of matroids and graphs.*
(157)

Thomas Zaslavsky, State University of New
York, Binghamton (859-05-29)

AMS Special Session on Ring Theory, III

8:00 a.m.–11:50 a.m.

- 8:00 a.m. *The enumeration of finite chain rings.*

(158) **Yousif Al-Khamees**, King Saud University,
Saudi Arabia (859-16-96)

- 8:30 a.m. *Injectivity, P -injectivity and V -rings.*

(159) **Roger Yue Chi Ming**, University of Paris VII,
France (859-16-60) (Sponsored by S. K. Jain)

- 9:00 a.m. *CS -modules with chain conditions.*

(160) **V. Camillo**, University of Iowa, and **M. F. Yousif***, Ohio State University, Lima
(859-16-110)

- 9:30 a.m. *Orders in blocked triangular matrix rings.*

(161) **Ming-Sun Li**, Oberlin College, and **Julius Zelmanowitz***, University of California, Santa
Barbara (859-16-104)

- 10:00 a.m. *Nonsingular retractable modules and their endomorphism rings.*
(162)

Soumaya Khuri, East Carolina University
(859-16-27)

- 10:30 a.m. *On the weak-injectivity of rings.* Preliminary report.
(163)

Abdullah Al-Huzali, **S. K. Jain** and **S. R. Lopez-Permouth***, Ohio University, Athens
(859-16-87)

- 11:00 a.m. *Class decomposition of modules.*

(164) **Saad Mohamed**, Kuwait University, Kuwait
(859-16-44)

- 11:30 a.m. *Modules with chain conditions on superfluous submodules.*
(165)

Ibrahim AL-Khazzi and **Patrick F. Smith***,
University of Glasgow, Scotland (859-16-64)

Saturday, August 11 (cont'd)

AMS Special Session on Group Theory, III

8:00 a.m.-11:50 a.m.

- 8:00 a.m. *A numerical approach to rewriteability in finite groups.* (166)
Judy L. Leavitt, University of Illinois, Urbana-Champaign, **Gary J. Sherman***, Rose-Hulman Institute of Technology, and **Mark E. Walker**, University of Illinois, Urbana-Champaign (859-20-83)
- 8:30 a.m. *A special class of finite p -groups.* Preliminary report. (167)
Wolfgang P. Kappe, State University of New York, Binghamton (859-20-32)
- 9:00 a.m. *Property ν in groups.* Preliminary report. (168)
James C. Beidleman, University of Kentucky (859-20-10)
- 9:30 a.m. *Intersections of subgroup functors.* Preliminary report. (169)
Ben Brewster, State University of New York, Binghamton (859-20-24)
- 10:00 a.m. *On exact power margin groups.* Preliminary report. (170)
Luise-Charlotte Kappe, State University of New York, Binghamton (859-20-31)
- 10:30 a.m. *Levi-properties generated by varieties.* Preliminary report. (171)
Robert Fitzgerald Morse, IBM Corporation, Owego, New York (859-20-38)
- 11:00 a.m. *Non-normal projectivities of metacyclic p -groups.* (172)
Charles Holmes, Miami University (859-20-41)
- 11:30 a.m. *On the structure of dual-standard subgroups.* (173)
Stewart Stonehewer, Warwick University, England, and **Giovanni Zacher***, Università di Padova, Italy (859-20-40)

MAA Minicourse #10: Part A

8:00 a.m.-10:00 a.m.

CAS laboratory projects for calculus. **Carl Leinbach**, Gettysburg College

MAA Minicourse #6: Part C

8:00 a.m.-10:00 a.m.

Writing to learn mathematics. **Agnes Azzolino**, Middlesex County College

AMS Session on Algebraic Number Theory and Multiplicative Structures

8:00 a.m.-10:55 a.m.

- 8:00 a.m. *A note on fundamental properties of recurring series.* (174)
Joseph Arkin, **David C. Arney**, **Frank R. Giordano** and **Rickey A. Kolb***, United States Military Academy (859-11-54)
- 8:15 a.m. *Explicit construction of certain metacyclic extensions.* (175)
Stanley Gurak, University of San Diego (859-11-113) (Sponsored by Lynne B. Small)
- 8:30 a.m. *Small two variable exponential diophantine equations.* Preliminary report. (176)
Robert Styer, Villanova University (859-11-163)
- 8:45 a.m. *Narcissistic loops.* (177)
John F. Lamb, Jr., East Texas State University (859-11-04)
- 9:00 a.m. *Divisor functions and subgroups of dihedral groups.* (178)
David W. Jensen* and **Michael K. Keane**, United States Air Force Academy (859-11-06)
- 9:15 a.m. *The original manuscript of the generalized Fibonacci numbers combined with the generalized Pascal triangle.* (179)
Joseph Arkin*, **David C. Arney** and **Frank R. Giordano**, United States Military Academy (859-11-47)
- 9:30 a.m. *Supercube II.* (180)
Joseph Arkin, **David C. Arney*** and **Frank R. Giordano**, United States Military Academy (859-11-48)
- 9:45 a.m. *The structure of stochastic complements in irreducible stochastic matrices.* (181)
Peter M. Gibson, University of Alabama, Huntsville (859-15-62)
- 10:00 a.m. *The eigenvalue problem without determinants.* Preliminary report. (182)
William A. McWorter and **Leroy F. Meyers***, Ohio State University, Columbus (859-15-118)
- 10:15 a.m. *The isometries of certain finite dimensional normed spaces.* (183)
Rohan Hemasinha* and **James R. Weaver**, University of West Florida (859-15-90)
- 10:30 a.m. *Universal localization of \tilde{A}_{12} , twisted pencils of matrices, and indecomposable modules.* Preliminary report. (184)
Mike May, S. J., Cambridge, Massachusetts (859-16-121)
- 10:45 a.m. *Centroids and root systems.* (185)
Duncan J. Melville, Yale University (859-17-124) (Sponsored by George B. Seligman)

PME Contributed Paper Session

8:00 a.m.-10:45 a.m.

MAA Session on Liberal Arts Mathematics Courses, Part C

8:30 a.m.-10:55 a.m.

- 8:30 a.m. *A health sciences core curriculum sequence in mathematics.*
(186) **Henry C. Foehl**, Philadelphia College of Pharmacy and Science, Pennsylvania
- 8:45 a.m. *Mathematics for honors students in liberal arts and business.*
(187) **Satish C. Bhatnager*** and **Leonard Zane**, University of Nevada, Las Vegas
- 9:00 a.m. *Creating new avenues for liberal arts students.*
(188) **Dave Wells*** and **Lynn Schmitt**, Pennsylvania State University, New Kensington Campus
- 9:15 a.m. *Other people's math: What every student should know.*
(189) **Lucy L. Deephouse*** and **Timothy V. Craine**, Trinity College, Connecticut
- 9:30 a.m. *An attempt to teach mathematics.*
(190) **Kathleen A. Taylor**, Duquesne University
- 9:45 a.m. *Math and math anxious.*
(191) **Margaret Herzog**, Pacific Lutheran University
- 10:00 a.m. *Contemporary mathematics and its utilitarian value.*
(192) **Ronald J. Czocho**, Glassboro State College, New Jersey
- 10:15 a.m. *Who are the liberal arts students and what math is "practical" for them?*
(193) **Carole A. Bauer**, Triton College, Illinois
- 10:30 a.m. *Who is our customer and what does she need to know?*
(194) **JoAnne S. Growney**, Bloomsburg University
- 10:45 a.m. *What does all this have to do with mathematics?*
(195) **Barry Brunson**, Western Kentucky University

MAA-ACM Invited Address

8:50 a.m.-9:40 a.m.

- (196) *On the computational complexity of doing mathematics.*
Juris Hartmanis, Cornell University

AMS Special Session on Algebraic Geometry, III

9:00 a.m.-11:50 a.m.

- 9:00 a.m. *Mordell-Weil groups of extremal K3 surfaces.*
(197) **Rick Miranda**, Colorado State University (859-14-126)

9:30 a.m. *Determinantal transversality criteria.*

- (198) **Robert Speiser**, Brigham Young University (859-14-55)

10:00 a.m. *Rationally triangulable automorphisms.*

- (199) **James K. Deveney** and **David R. Finston***, Virginia Commonwealth University (859-13-30)

10:30 a.m. *The Gauss map of a generic genus 4 theta*

(200) *divisor. Preliminary report.*

- Robert Varley***, **Malcolm Adams**, **Clint McCrory** and **Theodore Shifrin**, University of Georgia (859-14-139)

11:00 a.m. *Minimal models of elliptic threefolds.*

- (201) **Antonella Grassi**, Duke University (859-14-94)

11:30 a.m. *Infinitesimal propagation of line bundles among curves on algebraic varieties. Preliminary report.*

- Yun-Gang Ye**, Duke University (859-14-164)

MAA CUPM Subcommittee on Calculus Reform and the First Two Years Panel Discussion

9:00 a.m.-10:20 a.m.

MAA-NAM Invited Address

9:55 a.m.-10:45 a.m.

- (203) *Intriguing problems about zeros in complex analysis.*

Carl Lindell Prather, Virginia Polytechnic Institute and State University

MAA Minicourse #11: Part A

10:15 a.m.-12:15 p.m.

Producing mathematics courseware with Mathematica: Calculus and Mathematica. **Don Brown**, **Horacio Porta** and **Jerry Uhl**, University of Illinois, Urbana

MAA Minicourse #12

10:15 a.m.-12:15 p.m.

Exploring statistics and discrete mathematics topics using inexpensive graphing calculators. **Franklin Demana** and **Bert K. Waits**, Ohio State University

MAA Minicourse #13: Part A

10:15 a.m.-12:15 p.m.

Spreadsheet based mathematical topics for nonmathematics majors. **V. S. Ramamurti**, University of North Florida

Saturday, August 11 (cont'd)

MAA-PME Undergraduate Student Paper Session

10:30 a.m.-12:20 p.m.

MAA Science Policy Committee Panel Discussion

10:30 a.m.-noon

State mathematics coalitions.

MAA-AWM Invited Address

11:00 a.m.-11:50 a.m.

- (204) *The uses of set theory.*
Judith Roitman, University of Kansas

National Science Foundation

noon-1:00 p.m.

AMS Special Session on Combinatorics, IV

1:00 p.m.-3:20 p.m.

- 1:00 p.m. *Large sets of disjoint combinatorial structures.*
(205) Preliminary report.
Luc Teirlinck, Auburn University, Auburn
(859-05-81)
- 1:30 p.m. *Invariant linear forms and regularity in codes
and designs.* Preliminary report.
(206) **A. R. Calderbank**, AT&T Bell Laboratories,
Murray Hill, New Jersey (859-05-70)
- 2:00 p.m. *Designs from maximal arcs and difference sets.*
(207) Preliminary report.
J. F. Dillon, National Security Agency
(859-05-150)
- 2:30 p.m. *The subconstituent algebra of a graph of thin
type.*
(208) **Paul Terwilliger**, University of Wisconsin,
Madison (859-05-107)
- 3:00 p.m. *On the diameter of Cayley graphs of
permutation groups.*
(209) **Laszlo Babai**, University of Chicago, and **Akos
Seress***, Ohio State University, Columbus
(859-05-148) (Sponsored by Dwijendra K.
Ray-Chaudhuri)

AMS Special Session on Ring Theory, IV

1:00 p.m.-3:20 p.m.

- 1:00 p.m. *The structure of Johns rings.*
(210) **Carl Faith***, Rutgers University, New
Brunswick, and **Pere Menal**, University
Autonoma de Barcelona, Spain (859-16-65)
- 1:30 p.m. *On right perfect localizations.*
(211) **Seog-Hoon Rim**, **Mark L. Teply***, University of
Wisconsin, Milwaukee, and **Blas Torrecillas**,
University of Granada, Spain (859-16-12)
- 2:00 p.m. *Minimal cogenerators need not be unique.*
(212) **Barbara L. Osofsky**, Rutgers University, New
Brunswick (859-16-50)
- 2:30 p.m. *Uniform modules over serial rings.*
(213) **Bruno J. Mueller***, McMaster University, and
Surjeet Singh, Kuwait University, Kuwait
(859-16-78)
- 3:00 p.m. *The second layer condition, links and
localization in serial rings with Krull dimension.*
(214) **Mary H. Wright**, Southern Illinois University,
Carbondale (859-16-25)

MAA Minicourse #10: Part B

1:00 p.m.-3:00 p.m.

CAS laboratory projects for calculus. **Carl Leinbach**,
Gettysburg College

MAA Minicourse #8: Part B

1:00 p.m.-3:00 p.m.

*A mathematician's introduction to the HP-48SX scientific
expandable calculator for first-time users.* **John Kenelly** and
Don LaTorre, Clemson University

AMS Session on Function Spaces

1:00 p.m.-3:10 p.m.

- 1:00 p.m. *The geometry of harmonic mappings.*
(215) **Abdallah Lyzzaik**, Kuwait University, Kuwait
(859-30-02)
- 1:15 p.m. *Linear functionals on some weighted Bergman
spaces.*
(216) **Maher M. H. Marzuq**, Kuwait University, Kuwait
(859-30-03)
- 1:30 p.m. *Homogeneous polynomials on L_p -spaces.*
(217) Preliminary report.
K. Sundaresan, Cleveland State University
(859-42-21)

- 1:45 p.m. *Approximation by partial sums of Fourier series.*
(218) **Syed M. Mazhar**, Ohio State University, Columbus and Kuwait University, Kuwait (859-42-93)
- 2:00 p.m. *Multi-tuple Shilov boundaries for function spaces.* Preliminary report.
(219) **Toma Tonev**, University of Toledo and Institute of Mathematics, Bulgaria (859-46-157)
- 2:15 p.m. *Range inclusion and factorization of operators on classical Banach spaces.*
(220) **Alfred D. Andrew**, Georgia Institute of Technology, and **W. M. Patterson***, Spelman College (859-47-115)
- 2:30 p.m. *Maxwell's principle for Lagrangian saddle functions.* Preliminary report.
(221) **Gregory B. Passty**, Southwest Texas State University (859-47-114)
- 2:45 p.m. *Diagonal operators in ideals.*
(222) **Michael Hoffman**, California State University, Los Angeles (859-47-159)
- 3:00 p.m. *Relations with composition products of set-valued mappings.*
(223) **Frank U. Williamson**, Vitry, France (859-49-20)

AMS Session on Numerical Methods and Mathematical Modelling

1:00 p.m.-2:40 p.m.

- 1:00 p.m. *Random processes of the form*
(224) $x_{n+1} = a_n x_n + b_n \pmod{p}$.
Martin Hildebrand, Harvard University (859-60-89)
- 1:15 p.m. *More about two-parameter SOR method.*
(225) **Saadat Moussavi**, University of Wisconsin, Oshkosh (859-65-134)
- 1:30 p.m. *Low velocity expressions for the force between moving charges.*
(226) **Domina Eberle Spencer***, University of Connecticut, Storrs, and **Shama Y. Uma**, Bridgewater State College (859-78-112)
- 1:45 p.m. *A two-layer compressible/incompressible mathematical model of ice deformation.* Preliminary report.
(227) **William A. Jones, Jr.**, Byrd Polar Research Center and Ohio State University, Columbus (859-86-135)
- 2:00 p.m. *An investigation into the mathematics behind allometry.*
(228) **Sue Ann Gaster**, College of Saint Mary (859-92-156) (Sponsored by John N. Mordeson)
- 2:15 p.m. *Geographic location theory: Selected topics.*
(229) **Sandra L. Arlinghaus**, Institute of Mathematical Geography (859-51-116)
- 2:30 p.m. *Introductory linear algebra and computers.* Preliminary report.
(230) **Firooz Khosraviyani**, University of Texas at Permian Basin (859-15-140)

AMS Session on Differential and Integral Equations

1:00 p.m.-3:10 p.m.

- 1:00 p.m. *A note on the gap between the first two eigenvalues of one dimensional Schrodinger operator with symmetric potential.*
(231) **Shoshana Abramovich**, Connecticut College (859-34-14)
- 1:15 p.m. *Quasilinear Jacobi differential equations.* Preliminary report.
(232) **Victor L. Shapiro**, University of California, Riverside (859-34-53)
- 1:30 p.m. *Nonlinear matrix differential equations.*
(233) **John Jones, Jr.**, Air Force Institute of Technology (859-34-91)
- 1:45 p.m. *A remark on the periodic solutions of autonomous second order differential equations.*
(234) **Pablo M. Salzberg*** and **B. Mehri**, University of Puerto Rico (859-34-160)
- 2:00 p.m. *Local existence and uniqueness of solutions of degenerate parabolic equations.*
(235) **Jeffrey R. Anderson**, Ball State University (859-35-11)
- 2:15 p.m. *Lax pairs, recursion operators and perturbations of integrable evolution equations.*
(236) **Russell L. Herman**, Saint Lawrence University (859-35-01)
- 2:30 p.m. *Existence and uniqueness of bounded solutions of perturbed integral equations.* Preliminary report.
(237) **M. N. Islam**, University of Dayton (859-45-43)
- 2:45 p.m. *Characterization of the Meijer transform.*
(238) **Elias Y. Deeba***, University of Houston, Downtown, and **E. L. Koh**, University of Regina (859-44-76)
- 3:00 p.m. *Generalized Hilbert's 16th problem.*
(239) **Ping-Xing Sheng**, State University of New York, Buffalo and University of California, Los Angeles (859-34-09)

MAA Earle Raymond Hedrick Lectures: Lecture III

1:15 p.m.-2:15 p.m.

- (240) *Spirals from Theodorus of Cyrene to meta-chaos. Theodorus goes wild.*
Philip J. Davis, Brown University

Saturday, August 11 (cont'd)

MAA-AMATYC Invited Address

2:30 p.m.-3:20 p.m.

- (241) *Crisis in mathematics education: Perspective from the two-year college.*
Karl J. Smith, Santa Rosa Junior College

MAA Minicourse #11: Part B

3:15 p.m.-5:15 p.m.

Producing mathematics courseware with Mathematica: Calculus and Mathematica. Don Brown, Horacio Porta and Jerry Uhl, University of Illinois, Urbana

MAA Minicourse #13: Part B

3:15 p.m.-5:15 p.m.

Spreadsheet based mathematical topics for nonmathematics majors. V. S. Ramamurti, University of North Florida

AMS Progress in Mathematics Lecture

3:35 p.m.-5:05 p.m.

- (242) *Λ -trees and their applications.*
John W. Morgan, Columbia University
(859-20-167)

MAA Committee on the Participation of Women Special Lecture

3:35 p.m.-4:25 p.m.

History of women in the MAA.

W. Wistar Comfort
AMS Associate Secretary
Middletown, Connecticut

Kenneth A. Ross
MAA Secretary
Eugene, Oregon

Presenters of Papers

Numbers following the names indicate the speakers' positions on the program.
◊ AMS-MAA Invited Lecturer
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Amherst, Massachusetts

University of Massachusetts, Amherst

October 20 – 21

First Announcement

The eight-hundred-and-sixtieth meeting of the American Mathematical Society will be held at the University of Massachusetts, Amherst, Massachusetts, on Saturday, October 20, and Sunday, October 21, 1990. All scientific sessions will be held in the Lederle Graduate Research Tower and several nearby buildings.

Invited Addresses

By invitation of the Eastern Sectional Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, the titles of their talks, and the scheduled times of presentation are:

CHRISTOPHER B. CROKE, University of Pennsylvania, *On the rigidity induced by the length of geodesics; problems and recent progress*, 11:00 a.m. Saturday.

WILLIAM M. GOLDMAN, University of Maryland, College Park, *Complex hyperbolic Kleinian groups*, 11:00 a.m. Sunday.

HENRY P. MCKEAN JR., New York University, Courant Institute, *Two symplectic structures*, 1:30 p.m. Sunday.

JOHN J. MALLET-PARET, Brown University, *Global dynamics of delay differential equations*, 1:30 p.m. Saturday.

Special Sessions

By invitation of the same committee, there will be nine special sessions of selected twenty-minute papers. The topics of these sessions, and the names and affiliations of the organizers, are as follows:

Hyperbolic manifolds, COLIN C. ADAMS, Williams College.

Lattices, geometry, and combinatorics, M. K. BENNETT, University of Massachusetts, Amherst, and GARRETT BIRKHOFF, University of Massachusetts, Amherst.

Non-linear mathematics in mathematics and science, MELVYN BERGER and ROBERT GARDNER, University of Massachusetts, Amherst.

Semigroups, HASKELL COHEN, University of Massachusetts, Amherst.

Discrete groups and geometric structures in 2, 3, and

4 dimensions, WILLIAM M. GOLDMAN, and BERNARD MASKIT, SUNY at Stony Brook.

Lie groups and algebraic groups, JAMES E. HUMPHREYS, and IVAN MIRKOVIĆ, University of Massachusetts, Amherst.

Algebraic graph theory, CHJAN LIM, Rensselaer Polytechnic Institute.

Ergodic theory, V. S. PRASAD, University of Lowell.

Aperiodicity and order, CHARLES RADIN, University of Texas, Austin, and MARJORIE SENECHAL, Smith College.

Abstracts for consideration for these sessions should have been submitted by the **July 16, 1990** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive before the August 6, 1990 abstract deadline**. Participants are reminded that a charge of \$16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Electronic Submission of Abstracts

This service is now available to those who use the TEX typesetting system and can be used with abstracts of papers to be presented at the sectional meetings of the AMS. Requests to obtain the package of files may be sent electronically on Internet to **abs-request@math.ams.com**. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When re-

Meetings

requesting the abstracts package, users should be sure to specify whether they want the plain TEX, AMS-TEX, or the L^AT_EX package.

Registration

The registration desk will be located in the 16th floor lobby of the Lederle Graduate Research Tower and will be open from 8:00 a.m. to 5:00 p.m. on Saturday, October 20, and, from 8:00 a.m. to noon on Sunday, October 21. The registration fees are \$30 for members of the AMS, \$45 for nonmembers, and \$10 for students or unemployed mathematicians.

Other Events of Interest

On Friday, October 19, there will be an international symposium on *Nonlinear Dynamics in Mathematics and Science*, hosted by the University of Massachusetts, Amherst, Department of Mathematics and Statistics, and sponsored by the Office of Naval Research. This conference will take place between 10:00 a.m. until the late evening in a single location convenient to the Mathematics Department. Many distinguished mathematicians and scientists from this country and abroad (Soviet Union, England, and Japan) have been invited to participate in this major event. Here is a chance to learn of many of the major research developments in this field and to meet many of the major contributors—all in one day. The invited participants include R. Coifman, R. Devaney, V. Dobrushin, C. Foias, L. E. Fraenkel, C. Jones, V. Judovich, G. Knightly, O. Ladyhenskaya, H. Matano, H. McKean, A. Polyakov, J. T. Stuart, and J. Toland. In relation to the conference there will be a two-day Special Session of invited talks on nonlinear dynamics on Saturday and Sunday organized by M. S. Berger and R. Gardner.

Social Event

There will be a social event hosted by the Department of Mathematics and Statistics, late Saturday afternoon.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Columbus meeting announcement in the April 1990 issue of *Notices*.

Accommodations

Rooms have been blocked for participants at the following hotels or motels in the area. Because of the popularity of the New England fall foliage, hotel/motel reservations should be made as soon as possible. Participants should

make their own reservations directly and mention the AMS meeting. The deadline for reservations at the Lincoln Campus Center is September 29th; Lord Jeffery Inn, October 5th; Motel 6, September 30th; Country Belle Motel, September 9th; Howard Johnson Motel, September 19th; and University Motor Lodge, August 19th.

Country Belle Motel (two miles from campus)

392 Russell Street, Hadley, MA 01035 (Rte.9)
Telephone: 413-586-0715

Single \$54.00 Double \$54.00

Howard Johnson Motel (two miles from campus)

401 Russell Street, Hadley, MA 01035 (Rte.9)
Telephone: 413-586-0114

Single \$85.00 Double \$85.00

Lincoln Campus Center Hotel (on campus)

University of Massachusetts, Amherst, MA 01003
Telephone: 413-549-6000

Single \$54.00 Double \$64.00

Lord Jeffery Inn (one mile from campus)

30 Boltwood Avenue, Amherst, MA 01002
Telephone: 413-253-2576

Single \$80.00 Double \$80.00

Motel 6 (ten miles from campus)

State Road, (I-91 Exit 24, North rte. 5 and 10), South Deerfield, MA 01373
Telephone: 413-665-7161

Single \$29.56 Double \$36.15

University Motor Lodge (1/4 mile from campus)

345 North Pleasant Street, Amherst, MA 01002
Telephone: 913-527-8468

Single \$67.00 Double \$67.00

Food Service

Meals will be available at the following campus locations. Saturday only: Top of the Campus Restaurant (located in Lincoln Campus Center on the 11th floor) Hours from 5:00 p.m. to 9:00 p.m.

Saturday and Sunday: Hatch Cafeteria 8:00 a.m. - 10:30 p.m. Saturday: Newman Center 8:30 a.m. - 4:00 p.m. Sunday: Newman Center 8:30 a.m. - 10:00 p.m.

Parking

Parking will be permitted in any of the parking lots on campus from 6:00 p.m. Friday until 7:00 a.m. Monday at no charge. The only restrictions apply to spaces indicated as reserved for handicapped or towing zone

areas. Parking at other hours is available for a fee at the parking garage adjacent to the Lincoln Campus Center.

Travel and Local Information

The University of Massachusetts, Amherst, is accessible by air, bus, or car. In the town of Amherst there is no taxi service but it is expected that Pioneer Valley Transit Authority (PVTA) bus service will be available to and from the campus. Amherst is approximately a one-hour drive from Bradley International Airport in Windsor Locks, Connecticut, which is served by such major airlines as American, Delta, Eastern, TWA, United, and USAIR.

Participants are advised to fly in and out of Bradley since it is closer and more convenient than Logan International Airport in Boston. Peter Pan Bus Line is available at Bradley and runs directly to the campus. Peter Pan presently operates daily between the hours of 7:00 a.m. and 8:15 p.m. (10:15 p.m. on Friday). Return buses to Bradley from the campus presently operate daily from 5:05 a.m. until 6:20 p.m. (8:20 p.m. on Sunday).

Most major car rental companies have agencies at Bradley International Airport. Directions for participants driving to the meeting are as follow:

FROM THE NORTH: Route 91 South to Exit 25 (South Deerfield) onto Route 116 South to UMass Exit onto Massachusetts Avenue.

FROM THE SOUTH: Route 91 North to Exit 19 (Amherst) onto Route 9 to Route 116 North (left turn at lights) to UMass Exit onto Massachusetts Avenue (turn right).

FROM THE EAST: Massachusetts Turnpike (Route 90) West to Exit 4 (West Springfield), onto Route 91 North (Holyoke Exit) to Exit 19 (Amherst), onto Route 9 to Route 116 North (left turn at lights), to UMass Exit onto Massachusetts Avenue (turn right).

FROM THE WEST: Massachusetts Turnpike (Route 90) to Exit 4 (West Springfield), onto Route 91 North (Holyoke Exit) to Exit 19 (Amherst), onto Route 9 to Route 116 North (left turn at lights) to UMass Exit onto Massachusetts Avenue (turn right).

Weather and Local Attractions

Weather conditions in October can vary greatly. Balm Indian Summer weather is expected, but rapid changes in conditions have brought on snow storms in the past. Participants should be prepared for both warm and cold conditions.

W. Wistar Comfort
Associate Secretary
Middletown, Connecticut

ALMOST PERIODIC MEASURES

Loren N. Argabright and Jesús Gil de Lamadrid

(Memoirs of the AMS, Number 428)

In this book, the authors provide a thorough and organized presentation of a substantial portion of current research in abstract harmonic analysis carried out on three continents, in a field that has been characterized by multiple rediscoveries of results and concepts by authors unaware of the work of others. The book recasts the classical theory of H. Bohr of almost periodic functions in a form sufficiently abstract and general as to encompass not only Bohr's original theory, but also more recent manifestations of almost periodicity in the work of Wiener, Stepanov, Besicovitch, Eberlein, and Jacobs. A substantial portion of the book is devoted to the application of the general theory to the study of mixed norm (amalgam) space and to the study of the general Fourier transform introduced by the same authors in an earlier work (*Memoirs of the AMS*, Number 145). The present book builds on basic notions and systematically develops the concepts and results in a leisurely manner from the general to the concrete, with each step leading naturally to the next. In addition, it provides a simple, general framework for formulating and proving general results, which easily lead to many major, loosely related results in the existing literature.

Requiring a solid grounding in the theory of locally compact abelian groups and abstract (or classical) Fourier analysis, this book will be of interest to advanced graduate students in abstract harmonic analysis and topological representation theory, as well as to researchers in Fourier analysis, almost periodicity, and ergodic theory.

1980 *Mathematics Subject Classifications*: 43
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219 pages (softcover), May 1990

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Denton, Texas

University of North Texas

November 2-3

First Announcement

The eight-hundred-and-sixty-first meeting of the American Mathematical Society will be held at University of North Texas, Denton, Texas on Friday, November 2, and Saturday, November 3, 1990. All scientific sessions will be held in the Union Building on the campus.

Invited Addresses

By invitation of the Central Section Program Committee, there will be four invited one-hour addresses. The speakers, their affiliations, and the titles of their talks where available are:

AVNER D. ASH, Ohio State University, *Title to be announced.*

PETER S. CONSTANTIN, University of Chicago, *Title to be announced.*

JOHN E. LUECKE, University of Texas, Austin, *Title to be announced.*

CLARENCE WILKERSON, Perdue University, *Title to be announced.*

Special Sessions

By invitation of the same committee, there will be eleven Special Sessions of selected twenty-minute papers. The topics, and the names and affiliations of the organizers, are as follows:

Arithmetic groups, AVNER D. ASH and MARK S. REEDER, University of Oklahoma.

Geometric inequalities and convex bodies, ILYA BAKELMAN, Texas A & M University.

Banach spaces-functional analysis, ELIZABETH M. BATOR, RUSSELL G. BILYEU, and PAUL W. LEWIS, University of North Texas, Denton.

Commutative algebra, SCOTT T. CHAPMAN, Trinity University, and NICK H. VAUGHN, University of North Texas, Denton.

Texas topology and geometry, DANIEL S. FREED, ROBERT F. WILLIAMS, and MICHAEL WOLF, University of Texas, Austin.

The probability theory of patterns and runs, ANANT P. GODBOLE, Michigan Technological University.

Low dimensional topology, JOHN LUECKE and ROBERT MYERS, Oklahoma State University.

Representation theory of Lie groups, LISA MANTINI and ROGER C. ZIERAU, Oklahoma State University

Differential equations, JOHN W. NEUBERGER and HENRY A. WARCHALL, University of North Texas, Denton.

Algebraic geometry, PETER F. STILLER, Texas A & M University.

Several complex variables, EMIL J. STRAUBE, Texas A & M University.

Abstracts for consideration for these sessions should have been submitted by the July 16, 1990 deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, so as to arrive before the August 6, 1990 abstract deadline. Participants are reminded that a charge of \$16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Electronic Submission of Abstracts

This service is now available to those who use the T_EX typesetting system and can be used with abstracts of papers to be presented at the sectional meetings of the AMS. Requests to obtain the package of files may be sent electronically on Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: American Mathematical Society, Publications Division,

P.O. Box 6248, Providence, RI 02940, USA. When requesting the Abstracts package, users should be sure to specify whether they want the plain **TEX**, **AMS-TEX**, or the **L^ATEX** package.

Registration

The meeting registration desk will be located in the Gallery Reception Area in the Union Building and will be open from 7:00 p.m. to 9:00 p.m. on Thursday, from 8:00 a.m. to 2:00 p.m. on Friday, and from 8:00 a.m. to noon on Saturday. The registration fees are \$30 for members of the AMS, \$45 for nonmembers, and \$10 for students or unemployed mathematicians.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Columbus meeting announcement in the April 1990 issue of *Notices*.

Accommodations

Special rates have been negotiated at selected local hotels, all of which are located on the I-35 corridor. Both the Royal Hotel Suites and the Sheraton are within easy walking distance of the campus. Participants should make their own arrangements directly with the hotel of their choice and ask for the special AMS meeting rate. The rates listed are subject to change and do not include applicable taxes. The deadline for reservation at all locations is **October 1, 1990 to obtain the published rates**. The AMS is not responsible for rate changes or accommodations offered by hotels/motels.

Holiday Inn (2.5 miles from campus)

1500 Dallas Drive, Denton, TX 76205
Telephone: 817-387-3511

Single \$40.00 Double \$40.00

LaQuinta Motor Inn (1.5 miles from campus)

700 Fort Worth Drive, Denton, TX 76205
Telephone: 817-387-5840

Single \$31.00 Double \$36.00

Motel 6 (3 miles from campus)

I-35 North of University Drive, Denton, TX 76205
Telephone: 817-566-4798

Single \$21.95 Double \$27.95

Auburn Inn (2 miles from campus)

820 S I-35E at Teasley Lane, Denton, TX 76205
Telephone: 817-387-0591

Single \$35.00 Double \$35.00

Royal Hotel Suites (.5 miles from campus)

1210 I-35E, Denton, TX 76205
Telephone: 817-383-2007

Single \$24.00 Double \$34.00

Sheraton Hotel (.5 miles from campus)

2211 I-35E, Denton, TX 76205
Telephone: 817-565-8499

Single \$53.00 Double \$58.00

Food Service

Many fast food restaurants are located within two blocks of the campus, and more formal dining is available at the Sheraton Hotel and several local restaurants. Food service in the Union will only be available according to the following schedule: Breakfast, lunch, and sandwiches until 5:00 p.m. on Thursday; breakfast and lunch on Friday; and lunch only on Saturday.

Travel

Denton is located approximately 35 miles north of Dallas and Fort Worth and 25 miles north of DFW International Airport, which is served by most major airlines. Airport shuttle service is available from the DFW International Airport to Denton (Telephone 817-565-9936 two to five days in advance for reservations). However, since one-way fare is \$16 and only the Royal Hotel Suites and the Sheraton Hotel are within easy walking distance from campus, those flying to DFW should consider renting a car and driving to Denton.

Weather

Autumn in North Texas is a pleasant season with mild, sunny weather punctuated by short periods of rainfall. The average temperature for November is 61.5 degrees Fahrenheit with relative humidity around 55 percent. The average date of the first freeze is November 8.

Andy Roy Magid
Associate Secretary
Norman, Oklahoma

Irvine, California University of California, Irvine November 10 – 11

First Announcement

The eight-hundred-and-sixty-second meeting of the American Mathematical Society will be held at the University of California, Irvine (UCI) campus at Campus Blvd in Irvine, California on Saturday, November 10th, and Sunday, November 11th, 1990. All Special Sessions and sessions for contributed papers will be held in the Physical Sciences complex: Physical Sciences I or II, the Physical Sciences Lecture Hall or the Physical Sciences Lecture Facility. This meeting will be held in conjunction with a meeting of the Southern California Section of the Mathematical Association of America.

Invited Addresses

By invitation of the Western Section Program Committee, there will be three invited one-hour addresses. The speakers, their affiliations, and the titles of their talks where available are:

JENNIFER T. CHAYES, University of California, Los Angeles, *Nature of the critical phenomenon in self-organized criticality*.

MICHAEL D. FRIED, University of California, Irvine, *Parameter spaces in the inverse Galois Problem*.

NICHOLAS J. KOREVAAR, University of Utah, *Constant mean curvature surfaces*.

Special Sessions

By invitation of the same committee, there will be eight Special Sessions of selected twenty-minute papers. The topics and the names and affiliations of the organizers, are as follows:

Combinatorial groups, FRANK CANNITTO, University of California, Irvine.

Probability theory in mathematical physics, JENNIFER T. CHAYES, and GLEN H. SWINDLE, University of California, Los Angeles.

Interactions between group theory and logic, PAUL C. EKLOF, University of California, Irvine.

Interactions between group theory and geometry/number theory, MICHAEL D. FRIED and ROBERT M. GURALNICK, University of California, Irvine.

Moduli space applications, MICHAEL D. FRIED and DAVID HARBATER, University of California, Irvine.

Quantum and statistical mechanics, ABEL KLEIN, University of California, Irvine.

Geometric p.d.e.'s: mean and scalar curvature problems, NICHOLAS J. KOREVAAR and ANDREJS E. TREIBERGS, University of Utah.

Operator theory/operator algebras, BERNARD RUSSO, University of California, Irvine.

Abstracts for consideration for these sessions should have been submitted by the **July 16, 1990** deadline. This deadline was previously published in the Calendar of AMS Meetings and Conferences and in the Invited Speakers and Special Sessions section of the *Notices*.

Contributed Papers

There will also be sessions for contributed ten-minute papers. Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in Departments of Mathematics. Abstracts should be sent to the Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, **so as to arrive before the August 6, 1990 abstract deadline**. Participants are reminded that a charge of \$16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accommodated.

Electronic Submission of Abstracts

This service is now available to those who use the T_EX typesetting system and can be used with abstracts of papers to be presented at the spring sectional meetings of the AMS. Requests to obtain the package of files may be sent electronically on Internet to **abs-request@math.ams.com**. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When

requesting the abstracts package, users should be sure to specify whether they want the plain **TEX**, **AMS-TEX**, or the **L^AT_EX** package.

Registration

The meeting registration desk will be located in the lobby of the Physical Sciences II building, near Parking Lot 12, and will be open from 8:00 a.m. to 4:00 p.m. on Saturday, and 8:00 a.m. to noon on Sunday. The registration fees are \$30 for members of the AMS, \$45 for nonmembers, and \$10 for students or unemployed mathematicians. There is a special one-day fee of \$15 for MAA members on Saturday only.

Social Event

The MAA portion of the Conference will have a luncheon speaker, Harvey B. Keynes. On Saturday night, various of the Special Session organizers have been encouraged to arrange a dinner of Special Session attendees and speakers. Participants are encouraged to ask any Special Session organizer about this event.

Petition Table

A petition table will be set up in the registration area. Additional information about petition tables can be found in a box in the Columbus meeting announcement in the April 1990 issue of *Notices*.

Accommodations

Unfortunately, there is no housing available on the campus during the year; however, four of the hotels do offer shuttle service to UCI. All hotels offer shuttle service to and from Orange County Airport (on MacArthur Blvd) and taxi service is available from each hotel to the UCI campus. Hotel listings will appear in the September *Notices*.

Food Service

On the UCI campus, lunch will be available at "Joe's on the Green," which serves hefty sandwiches, many flavors of pizza, pasta, beer, wine, etc. It will be open especially for the conference and service is expected to be excellent. For more formal dining, the "Market Place" across from Campus Boulevard has wonderful shops and at least four restaurants, one of them serving Chinese food.

Travel

There are two convenient airports to the conference: Los Angeles International Airport (LAX) and Orange County

Airport (OCA)) also known as the John Wayne Airport. Shuttle service is available to UCI or to any of the hotels from OCA. There is also a convenient shuttle or bus service from LAX to OCA. For participants traveling by car to the campus, please see the following directions: **LAX to MacArthur Boulevard:** When leaving LAX, take the Sepulveda exit. Stay in the right lane on Sepulveda until you see a sign that says **405 South**. Turn right at that corner and then immediately get in the left lane for merging into the freeway traffic, drive (for approximately 45 minutes) until you see the exit across from OCA. The streets for Irvine include MacArthur Blvd, Jamboree, and Culver. Turn left on **MacArthur Blvd**, heading for the beach. Drive approximately five minutes past Jamboree and under a viaduct, to **University Ave** exit. At that point, you will see a sign for UCI; turn right and drive down the long exit ramp to the bottom of the hill. Turn right and enter the campus on the first street, **California Street**. Follow the signs to the parking Kiosk, the Sciences Complex and Parking Lot 12.

Parking

The UCI Physical Sciences Complex is located near a collection of large parking lots on Circle Drive. Principal among these is Parking Lot 12. There is no parking fee on Sunday. Kiosks for the parking stickers for Saturday are located at all three large entrance streets (California, Bridge, and Berkeley) to the University. Parking stickers are \$4 for all day and \$3 for half a day.

Weather and Local Attractions

The famous Southern California weather is characterized by warm breezes during the day—dare we say balmy—followed by cool exotic nights. Even in November, one can expect comfortable temperatures (75°F in the afternoon, 65°F in the evening). It is as advertised. The local attractions are of the nature of amusement park type: the renowned beaches (especially Main beach in Laguna Beach), the marsh lands tour on UCI campus, Disneyland, and Knotts Berry Farm (only 15 minutes from the campus). A special tour of the marsh lands has been arranged for Saturday, November 10, at 10:00 a.m. For the serious shopper, *Fashion Island* is the place to go. It is the closest thing in the UCI area to Rodeo Drive and it is much prettier. Finally, the search for quintessential Southern California ends at Balboa Island. This combines fantastic dining and viewing on an inlet.

Lance W. Small
Associate Secretary
La Jolla, California

Invited Speakers and Special Sessions

Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

Amherst, MA, October 1990

Christopher B. Croke	John J. Mallet-Paret
William M. Goldman	Henry P. McKean, Jr.

Denton, TX, November 1990

Avner D. Ash	John Luecke
Peter S. Constantin	Clarence W. Wilkerson

Irvine, CA, November 1990

Jennifer T. Chayes	Nicholas J. Korevaar
Michael D. Fried	

San Francisco, CA, January 1991

Michael F. Atiyah (Gibbs Lecture)	Robert D. MacPherson (Colloquium Lectures)
Shiing S. Chern (AMS/MAA Lecture)	Grigori Aleksandrovich Margulis
Rebecca A. Herb (AMS/MAA Lecture)	Frank Morgan (AMS/MAA Lecture)
Maria M. Klawe	Kenneth A. Ribet
	Héctor J. Sussmann

South Bend, IN, March 1991

Leonid G. Makar-Limanov	Stephen D. Smith
Donald G. Saari	Deane Yang

Tampa, FL, March 1991

Josefina Alvarez	Michel L. Lapidus
Ronald A. DeVore	Donald St. P. Richards

Orono, ME, August 1991

Richard M. Schoen (Progress in Mathematics Lecture)
--

Fargo, ND, October 1991

Ian D. Macdonald	Sylvia M. Wiegand
Harald Upmeyer	

Baltimore, MD, January 1992

Michael E. Fisher
(Gibbs Lecture)

Invited addresses at Sectional Meetings are selected by the Section Program Committee, usually twelve to eighteen months in advance of a meeting. Members wishing to nominate candidates for invited addresses should send the relevant information to the Associate Secretary for the Section who will forward it to the Section Program Committee.

Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled **Information for Organizers** describes the timetable for announcing the existence of Special Sessions.

October 1990 Meeting in Amherst, Massachusetts Eastern Section

Associate Secretary: W. Wistar Comfort

Deadline for organizers: Expired

Deadline for consideration: Expired

Colin C. Adams, <i>Hyperbolic manifolds</i>
M. K. Bennett and Garrett Birkhoff, <i>Lattices, geometry, and combinatorics</i>
Melvyn S. Berger and Robert A. Gardner, <i>Nonlinear dynamics in mathematics and science</i>
Haskell Cohen, <i>Semigroups</i>
William M. Goldman and Bernard Maskit, <i>Discrete groups and geometric structures in 2, 3 and 4 dimensions</i>
James E. Humphreys and Ivan Mirković, <i>Lie groups and algebraic groups</i>
Chjan C. Lim, <i>Algebraic graph theory</i>

V. S. Prasad, *Ergodic theory*
 Charles Radin and Marjorie Senechal, *Aperiodicity and order*

November 1990 Meeting in Denton, Texas

Central Section

Associate Secretary: Andy R. Magid

Deadline for organizers: Expired

Deadline for consideration: Expired

Avner D. Ash and Mark S. Reeder, *Arithmetic groups*
 Elizabeth M. Bator, Russell G. Bilyeu and Paul W. Lewis, *Banach spaces—functional analysis*
 Ilya Bakelman, *Geometric inequalities and convex bodies*
 Scott T. Chapman and Nick H. Vaughan, *Commutative algebra*
 Daniel S. Freed, Robert F. Williams and Michael Wolf, *Texas topology and geometry*
 Anant P. Godbole, *The probability theory of patterns and runs*
 John Luecke and Robert Myers, *Low dimensional topology*
 Lisa Mantini and Roger C. Zierau, *Representation theory of Lie groups*
 John W. Neuberger and Henry A. Warchall, *Differential equations*
 Peter F. Stiller, *Algebraic geometry*
 Emil J. Straube, *Several complex variables*

November 1990 Meeting in Irvine, California

Western Section

Associate Secretary: Lance W. Small

Deadline for organizers: Expired

Deadline for consideration: Expired

Frank Cannitto, *Combinatorial groups*
 Jennifer T. Chayes and Glen H. Swindle, *Probability theory in mathematical physics*
 Paul C. Eklof, *Interactions between group theory and logic*
 Michael D. Fried and Robert M. Guralnick, *Interactions between group theory and geometry/number theory*
 Michael D. Fried and David Harbater, *Moduli space applications*
 Abel Klein, *Quantum and statistical mechanics*
 Nicholas J. Korevaar and Andrejs E. Treibergs, *Geometric p.d.e.'s: mean and scalar curvature problems*
 Bernard Russo, *Operator theory/operator algebras*

January 1991 Meeting in San Francisco, California

Associate Secretary: Andy R. Magid

Deadline for organizers: Expired

Deadline for consideration: September 19, 1990

Alok Aggarwal and Maria M. Klawe, *To be announced*
 Frederick J. Almgren, Albert Marden and Jean E. Taylor, *Computing optimal geometries*
 William Beckner and J. Michael Pearson, *Geometric Fourier analysis*

Melvyn S. Berger, *Turbulence*
 Bruce E. Blackadar, *C^* -algebras and noncommutative topology*
 Ed Dubinsky and James J. Kaput, *Research in undergraduate education (AMS/MAA Session)*
 Naomi Fisher, Harvey B. Keynes and Philip D. Wagreich, *Mathematics and education reform*
 John R. Graef and Jack K. Hale, *Oscillation and dynamics in delay equations*
 Kevin A. Grasse and Héctor J. Sussmann, *To be announced*
 Helmut Groemer and Jane Yeager, *Analytical methods in convexity*
 William B. Jacob, *Real algebraic geometry*
 Victor J. Katz and David E. Rowe, *History of mathematics*
 Esther R. Lamken, *Combinatorial design theory*
 Kirk E. Lancaster, *Boundary behavior in partial differential equations*
 M. Susan Montgomery and Earl J. Taft, *Hopf algebras*
 David Mumford, *Automatic theorem proving*
 Kenneth A. Ribet, *Arithmetical algebraic geometry*
 Lester J. Senechal, *Research papers by undergraduates*
 Antoinette Trembinska, *Entire function theory*

March 1991 Meeting in South Bend, Indiana

Central Section

Associate Secretary: Andy R. Magid

Deadline for organizers: Expired

Deadline for consideration: December 13, 1990

Gail R. Letzter, Peter Malcolmson and Frank Okoh, *Noncommutative ring theory*

March 1991 Meeting in Tampa, Florida

Southeastern Section

Associate Secretary: Joseph A. Cima

Deadline for organizers: Expired

Deadline for consideration: December 13, 1990

June 1991 Meeting in Portland, Oregon

Western Section

Associate Secretary: Lance W. Small

Deadline for organizers: September 13, 1990

Deadline for consideration: March 5, 1991

August 1991 Meeting in Orono, Maine

Associate Secretary: Lance W. Small

Deadline for organizers: November 15, 1990

Deadline for consideration: May 8, 1991

October 1991 Meeting in Philadelphia, Pennsylvania

Eastern Section

Associate Secretary: W. Wistar Comfort

Deadline for organizers: January 10, 1991

Deadline for consideration: July 11, 1991

Invited Speakers and Special Sessions

October 1991 Meeting in Fargo, North Dakota
Central Section

Associate Secretary: Andy R. Magid

Deadline for organizers: January 25, 1991

Deadline for consideration: July 11, 1991

Dogan Comez, *Ergodic theory*Kendall E. Nygard, *Operations research*James H. Olsen and Mark Pavicic, *Mathematical foundations of computer graphics*Warren E. Shreve, *Graph theory*Vasant A. Ubhaya, *Approximation theory***November 1991 Meeting in Santa Barbara, California**
Western Section

Associate Secretary: Lance W. Small

Deadline for organizers: February 7, 1991

Deadline for consideration: August 20, 1991

January 1992 Meeting in Baltimore, Maryland

Associate Secretary: W. Wistar Comfort

Deadline for organizers: April 8, 1991

Deadline for consideration: September 11, 1991

March 1992 Meeting in Tuscaloosa, Alabama
Southeast Section

Associate Secretary: Joseph A. Cima

Deadline for organizers: June 13, 1991

Deadline for consideration: To be announced

March 1992 Meeting in Springfield, Missouri
Central Section

Associate Secretary: Andy R. Magid

Deadline for organizers: June 26, 1991

Deadline for consideration: To be announced

June 1992 Meeting in Cambridge, England

Associate Secretary: Robert M. Fossum

Deadline for organizers: September 28, 1991

Deadline for consideration: To be announced

January 1993 Meeting in San Antonio, Texas

Associate Secretary: Lance W. Small

Deadline for organizers: April 13, 1992

Deadline for consideration: To be announced

August 1993 Meeting in Vancouver,**British Columbia, Canada**

Associate Secretary: Andy R. Magid

Deadline for organizers: November 11, 1992

Deadline for consideration: To be announced

January 1994 Meeting in Cincinnati, Ohio

Associate Secretary: Joseph A. Cima

Deadline for organizers: April 5, 1993

Deadline for consideration: To be announced

January 1996 Meeting in Orlando, Florida

Associate Secretary: W. Wistar Comfort

Deadline for organizers: April 12, 1995

Deadline for consideration: To be announced

Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings (PCNM). They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the "Rules for Special Sessions" of the Society, Special Sessions are selected by the PCNM from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but can be found in "Rules for Special Sessions" on page 614 in the April 1988 issue of *Notices*.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the PCNM or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an *ex-officio* member of the committee and whose address may be found below). These proposals must be in the hands of the PCNM at least nine months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to *Notices*, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noted that Special Sessions must be announced in *Notices* in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three weeks before the deadline for abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. The processing of proposals for Special Sessions for Sectional Meetings is handled in essentially the same manner as for Annual and Summer Meetings by the Section Program Committee. Again, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for and organizing of Special Sessions may be found in the "Rules for Special Sessions" or may be obtained from any Associate Secretary.

Proposals for Special Sessions to the Associate Secretaries

The programs of Sectional Meetings are arranged by the Associate Secretary for the section in question:

Western Section

Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
Electronic mail: g_small@math.ams.com
(Telephone 619-534-3590)

Central Section

Andy R. Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
Electronic mail: g_magid@math.ams.com
(Telephone 405-325-6711)

Eastern Section

W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
Electronic mail: g_comfort@math.ams.com
(Telephone 203-347-9411)

Southeastern Section

Joseph A. Cima, Associate Secretary
Department of Mathematics
University of North Carolina, Chapel Hill
Chapel Hill, NC 27599-3902
Electronic mail: g_cima@math.ams.com
(Telephone 919-962-1050)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single Special Session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Electronic submission of abstracts is now available to those who use the T_EX typesetting system. Requests to obtain the package of files may be sent electronically via the Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Electronic Abstracts, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940, USA. When requesting the abstracts package, users should be sure to specify whether they want the plain T_EX, A_MS-T_EX, or the L^AT_EX package.

Number of Papers Presented Joint Authorship

Although an individual may present only one ten-minute contributed paper at a meeting, any combination of joint authorship may be accepted, provided no individual speaks more than once. An author can speak by invitation in more than one Special Session at the same meeting.

An individual may contribute only one abstract by title in any one issue of *Abstracts*, but joint authors are treated as a separate category. Thus, in addition to abstracts from two individual authors, one joint abstract by them may also be accepted for an issue.

Site Selection for Sectional Meetings

Sectional Meeting sites are recommended by the Associate Secretary for the Section and approved by the Committee of Associate Secretaries and Secretary. Recommendations are usually made eighteen to twenty-four months in advance. Host departments supply local information, ten to twelve rooms with overhead projectors for contributed paper sessions and special sessions, an auditorium with twin overhead projectors for invited addresses, and registration clerks. The Society partially reimburses for the rental of facilities and equipment, and for staffing the registration desk. Most host departments volunteer; to do so, or for more information, contact the Associate Secretary for the Section.

Joint Mathematics Meetings in San Francisco

AMS Special Sessions and Contributed Papers

MAA Contributed Papers

The Joint Mathematics Meetings in San Francisco will be held January 16–19 (Wednesday–Saturday), 1991. The first full announcement of the meeting will appear in the October 1990 issues of *Notices* and *Focus*. This preliminary announcement is made to encourage members' participation and to provide lead time for submission of abstracts for consideration in AMS Special Sessions and for submission of abstracts for AMS and MAA Contributed Paper Sessions.

AMS Special Sessions

It is hoped that the list of Special Sessions for this meeting will be available in the next issue of *Notices*.

Most of the papers to be presented at these Special Sessions will be by invitation; however, anyone contributing an abstract for the meeting who feels that his or her paper would be particularly appropriate for one of these sessions should indicate this clearly on the abstract, and should submit it by September 19, 1990, three weeks earlier than the normal deadline for contributed papers, in order that it be considered for inclusion.

Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940. A charge of \$16 is imposed for retyping abstracts that are not in camera-ready form.

AMS Contributed Paper Sessions

Abstracts should be prepared on the standard AMS form available from the AMS office in Providence or in departments of mathematics, and should be sent to Abstracts, Editorial Department, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940, so as to arrive by the abstract deadline of October 10, 1990. A charge of \$16 is imposed for retyping abstracts that are not in camera-ready form. Late papers will not be accepted.

Electronic Submission of AMS Abstracts

This service is now available to those who use the T_EX typesetting system and can be used for abstracts of papers to be presented at this meeting. Requests to obtain the package of files may be sent by electronic mail on the

Internet to abs-request@math.ams.com. Requesting the files electronically will likely be the fastest and most convenient way, but users may also obtain the package on IBM or Macintosh diskettes, available free of charge by writing to: Secretary to Director of Publication, American Mathematical Society, Publications Division, P.O. Box 6248, Providence, RI 02940. When requesting the abstracts package, users should be sure to specify whether they want the plain T_EX, A_MS-T_EX, or the L^AT_EX package. Again, late papers will not be accepted.

MAA Contributed Papers

Contributed papers are being accepted on several topics in collegiate mathematics for presentation in contributed paper sessions at the meeting. The topics, organizers, their affiliations, and the days they will meet are:

- *Professional development for teachers of mathematics*, JOHN DOSSEY, Illinois State University, and ELIZABETH J. TELES, Montgomery College, Maryland. Wednesday and/or Thursday.

This session is sponsored by the Committee on Faculty Development (John Dossey, chair). Papers are invited that describe departmental, system, state, regional, or sectional programs aimed at promoting continued faculty growth in mathematics or its teaching. Special consideration will be given to programs which are easily transported from one setting to another. Topics to be discussed can include, but are not limited to, the following: special faculty study programs, focused colloquia series, reading/study groups, teaching improvement programs, and the development and use of technological aids.

- *Statistics and probability*, SHELDON P. GORDON, Suffolk Community College, and FLORENCE S. GORDON, New York Institute of Technology. Friday and/or Saturday.

Contributed papers on any issue relating to statistics and probability courses in the mathematics curriculum are welcome. For instance, 1.) What are some innovative approaches to teaching these courses (such as the use of computers and other technology, simulations, exploratory data analysis or student "research" projects)? 2.) What does statistical literacy mean for liberal arts, science, mathematics, business or social science students? 3.) What statistical ideas are being introduced into the

secondary curriculum and what are the implications for the undergraduate curriculum?

- *Alternatives to the lecture method*, JAMES R.C. LEITZEL, The Ohio State University. Friday and/or Saturday.

This session, sponsored by the Committee on the Mathematical Education of Teachers (COMET), will be devoted to classroom practices which provide alternatives to a strictly lecture approach. Papers are solicited which address strategies and techniques for classroom practice across a variety of topics in the undergraduate curriculum. Presentations which represent large and small class size and upper division as well as lower division courses are desired.

- *Humanistic mathematics*, ALVIN WHITE, Harvey Mudd College and Humanistic Math Network, MARILYN FRANKENSTEIN, University of Massachusetts, Boston, and JOAN COUNTRYMAN, Germantown Friends High School. Wednesday and/or Thursday

Contributions are invited that describe teaching, using, or creating mathematics as a humanistic discipline. The paper should describe the experience and its effect, if any, on the point of view. Philosophical and/or historical papers that contribute to mathematics as a humanistic discipline are also welcome.

- *Lesser known geometrical gems*, DON CHAKERIAN, University of California, Davis, RICHARD PFEIFER, San Jose State University, and JANE SANGWINE-YAGER, Saint Mary's College. Wednesday and/or Thursday

Contributed papers are invited which illustrate interesting but not widely known results which may be used by the teacher to enliven an upper division geometry

course. These may include new insights and forgotten classics in geometry that deserve wider appreciation.

- *Using history in the teaching of mathematics*, DAVID E. ZITARELLI, Temple University. Friday and/or Saturday.

The history of mathematics is used in various ways to enrich and to teach mathematics. Papers in this session should address such uses in courses ranging from liberal arts courses for non-science majors to required courses for mathematics majors. Of particular interest are descriptions of history of mathematics courses, including graduate level courses and those designed for education majors.

Presentations are normally limited to ten minutes, although selected contributors may be given up to twenty minutes. Individuals wishing to submit papers for any of these sessions should send the following information to the MAA Washington office at 1529 Eighteenth Street, NW, Washington, DC 20036 by **September 25**:

1. A page giving the author's name, author's address, the intended session, and a one-paragraph abstract (for distribution at the meeting);
2. A one-page outline of the presentation.

Rooms where sessions of contributed papers will be held are equipped with overhead projector and screen. Blackboards are not available. Persons having other equipment needs should contact the MAA Associate Secretary (Kenneth A. Ross, Department of Mathematics, University of Oregon, Eugene, OR 97403) as soon as possible, but in any case **prior to November 16**. Upon request, the following will be made available: one additional overhead projector/screen, 35mm carousel slide projector, 16mm film projector, or VHS video cassette recorder with a color monitor.

International Congress of Mathematicians

Kyoto, JAPAN

August 21-29, 1990

List of Speakers

The following is the most current list of invited speakers just received from Kyoto. Please note that this is not the final program and is subject to change. Interested readers should refer to the Second Announcement of the Congress reproduced on pages 188-212 of the February 1990 issue of *Notices* for further information.

Plenary Speakers

- SPENCER BLOCH, *Recent work on motifs*
 STEPHEN A. COOK, *Complexity theory and logic*
 BORIS L. FEIGIN, *Lie cohomological approach to conformal field theory*
 ANDREAS FLOER, *Elliptic methods in Morse theory*
 YASUTAKA IHARA, *Braids, Galois groups and some arithmetic functions*
 VAUGHAN F. R. JONES, *Von Neumann algebras in topology and physics*
 LÁSZLÓ LOVÁSZ, *Geometric algorithms and algorithmic geometry*
 GEORGE LUSZTIG, *Character sheaves*
 ANDREW J. MAJDA, *The interaction of nonlinear analysis and modern applied mathematics*
 GREGORI A. MARGULIS, *Lie groups and ergodic theory*
 RICHARD B. MELROSE, *Pseudodifferential operators, corners and singular limits*
 SHIGEFUMI MORI, *Birational classification of algebraic threefolds*
 YAKOV G. SINAI, *Hyperbolic billiards*
 KAREN K. UHLENBECK, *Non-linear partial differential equations and topology*
 ALEXANDER N. VARCHENKO, *Multidimensional hypergeometric functions and their appearance in conformal field theory, algebraic K-theory, algebraic geometry, etc.*

Section 1 - Mathematical Logic and Foundations

- EHUD HRUSHOVSKI, *Categorical structures*
 THEODORE A. SLAMAN, *Degree structures*
 JOHN R. STEEL, *Iteration trees*
 LOU VAN DEN DRIES, *The logic of local fields*

Section 2 - Algebra

- JON F. CARLSON, *Cohomology and modules over group algebras*
 ROSTISLAV I. GRIGORCHUK, *On the growth in group theory*
 CRAIG HUNEKE, *Infinite integral extensions and Cohen-Macaulay rings*
 ALEXANDER R. KEMER, *Identities of associate algebras*
 PAUL ROBERTS, *Intersection theory and the homological conjectures in commutative algebra*
 KLAUS W. ROGGENKAMP, *The isomorphism problem for integral group rings*
 ROBERT W. THOMASON, *The local to global principle in algebraic K-theory*
 EFIM I. ZELMANOV, *Restricted Burnside problem*

Section 3 - Number theory

- HENRI GILLET, *The Riemann-Roch theorem in arithmetic geometry*
 MARTIN NEIL HUXLEY, *Area, lattice points and exponential sums*
 KAZUYA KATO, *Generalized class field theory*
 V. A. KOLYVAGIN, *On the Mordell-Weil and Shafarevich-Tate groups of modular elliptic curves*
 GÉRARD LAUMON, *Transformation de Fourier géométrique et formes automorphes*
 YU. V. NESTERENKO, *Algebraic independence of values of analytic functions*
 PETER SARNAK, *Analytic aspects of the theory of automorphic forms*
 TETSUJI SHIODA, *Theory of Mordell-Weil lattices*

Section 4 - Geometry

- ROBERT FRIEDMAN, *Algebraic surfaces and 4-manifolds*
 KENJI FUKAYA, *Collapsing Riemannian manifolds and its application*
 ETIENNE GHYS, *The circle at infinity of negatively curved surfaces*
 KARSTEN GROVE, *Metric and topological measurements of manifolds*
 HELMUT HOFER, *Symplectic invariants*

PETER BENEDICT KRONHEIMER, *Hyper-Kähler geometry and singularities in Yang-Mills moduli spaces*

DUSA MCDUFF, *New developments in symplectic geometry*

JOHN MILLSON, *Rational homotopy theory and deformation problems from algebraic geometry*

EUGENII I. SHUSTIN, *Geometry of discriminant and topology of algebraic curves*

JOSEF H. M. STEENBRINK, *Applications of Hodge theory to singularities*

TOSHIKAZU SUNADA, *Trace formulas in spectral geometry*

GANG TIAN, *Kähler-Einstein metrics on algebraic manifolds*

Section 5 – Topology

MARCEL BÖKSTEDT, *Algebraic K-theory of spaces and the Novikov conjecture*

FRANCIS BONAHO, *Low dimensional manifolds of negative curvature*

DAVID GABAI, *Foliations and the topology of 3-manifolds*

THOMAS G. GOODWILLIE, *The differential calculus of homotopy functors*

CAMERON M. GORDON, *Dehn surgery on knots*

KIYOSHI IGUSA, *Parametrized Morse theory and its applications*

LOWELL JONES, *Topological aspects of non-positively curved manifolds*

SHIGEYUKI MORITA, *Mapping class groups of surfaces and three dimensional manifolds*

HENRI MOSCOVICI, *Elliptic operators and invariants of non-simply connected manifolds*

VLADIMIR G. TURAEV, *State sum models in low-dimensional topology*

Section 6 – Algebraic Geometry

YUJIRO KAWAMATA, *Canonical singularities and minimal models of algebraic varieties*

JÁNOS KOLLÁR, *The structure of algebraic threefolds*

ROBERT LAZARSFELD, *Linear series on algebraic varieties*

MORIIHIKO SAITO, *Mixed Hodge modules*

LESLIE D. SAPER, *L_2 -cohomology of algebraic varieties*

CARLOS T. SIMPSON, *Non-abelian hodge theory*

PAUL VOJTA, *Arithmetic and Diophantine geometry*

Section 7 – Lie Groups and Representations

DAN BARBASCH, *Unipotent representations for real reductive groups*

GÜNTER HARDER, *Eisenstein cohomology of arithmetic groups and applications to arithmetic*

MASAKI KASHIWARA, *Crystalizing the q -analogue of enveloping algebras*

OLIVIER MATHIEU, *On the classification of graded simple Lie algebras*

TOSHIHIKO MATSUKI, *Orbits on flag manifolds*

COLETTE MOEGLIN, *Sur les formes automorphes de carré intégrable*

GOPAL PRASAD, *Semi-simple groups and arithmetic subgroups*

STEPHEN RALLIS, *L -functions and the oscillator representation*

Section 8 – Real and Complex Analysis

ERIC BEDFORD, *Iteration of polynomial automorphisms of C^2*

F. MICHAEL CHRIST, *Analysis on three-dimensional CR manifolds of finite type*

RONALD R. COIFMAN, *Operator analysis and numerical algorithms*

CURT McMULLEN, *Rational maps and Kleinian groups*

TAKAFUMI MURAI, *Analytic capacity*

TAKEO OHSAWA, *Recent applications of L^2 estimates for the operator $\bar{\partial}$*

DAVID PREISS, *Measures and differentiability in Banach spaces*

KYOJI SAITO, *Teichmüller modular function and growth of discrete groups*

NESSIM SIBONY, *Function theory on weakly pseudoconvex domains*

NICHOLAS TH. VAROPOULOS, *Analysis and geometry on groups*

A. L. VOLBERG, *What are the asymptotically holomorphic functions?*

Section 9 – Operator Algebras and Functional Analysis

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JOACHIM CUNTZ, *K-theory and cyclic cohomology*

ADRIAN OCNEANU, *Quantum symmetry, classification of subfactors and quantum field theory*

MIHAI PIMSNER, *K-theory for groups acting on trees*

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GEORGES SKANDALIS, *Operator algebras and the duality principle*

MICHEL TALAGRAND, *Some isoperimetric inequalities and their applications*

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PERSI DIACONIS, *Applications of group representations in probability and statistics*

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Section 15 - Mathematical Aspects of Computer Science

LÁSZLÓ BABAI, *Computational complexity in finite groups*

LENORE BLUM, *A theory of computation and complexity over the real numbers*

A. L. CHISTOV, *title to be announced*

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VALERY D. GOPPA, *Algebraic-geometric methods in computer science*

AVI WIGDERSON, *Communication complexity and Boolean circuit complexity*

Section 16 - Computational Methods

AMIRAM HARTEN, *Recent developments in shock-capturing schemes*

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Section 17 – Applications of Mathematics to the Sciences

PHILIP HOLMES, *Can dynamical systems approach turbulence?*

YVES MEYER, *Wavelets and applications*

MASAYASU MIMURA, *Pattern formation in reaction-diffusion systems*

Section 18 – History, Teaching and the Nature of Mathematics

ANNICK HORIUCHI, *Seki Takakazu (?-1708) and the development of mathematics in Japan during the Edo era (1600-1868)*

YURI I. MANIN, *Mathematics as metaphor*

HARUO MURAKAMI, *Teaching mathematics to students not majoring in mathematics – Present situation and future prospects*

ICMI Sessions

HIROSHI FUJITA, *Mathematical literacy and Japanese new mathematics curriculum*

MIGUEL DE GUZMÁN, *Games and puzzles and their role in the popularization of mathematics*

BERNARD HODGSON, *The ICMI studies: Some personal views*

YONG WOON KIM, *National mentality and mathematical education*

JACOBUS H. VAN LINT, *Structuring discrete mathematics*

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Providing an accessible introduction to the basics of fractals, this videotape presents an appealing balance of the theoretical and aesthetic aspects of the Mandelbrot set. Viewers will appreciate the clarity of exposition as John Hubbard uses a combination of lecture, boardwork, Macintosh computer demonstrations, and colorful computer-generated films and pictures to bring the concepts to life.

Part I focuses on iteration and Julia sets, while Part II addresses Mandelbrot sets. Part III examines a way of using the concept of electric field lines to understand these fractal sets. The concluding remarks round out the lecture by pointing to a philosophical framework that relate these sets to phenomena occurring in the natural world. Requiring only a background in calculus, this videotape will provide a useful tool in classrooms and would be an excellent addition to a videotape library.

1980 Mathematics Subject Classification: 58

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Symposium on Some Mathematical Questions in Biology

Neural Networks

Vancouver, Canada, August 2-3

The twenty-fourth annual Symposium on Some Mathematical Questions in Biology on *Neural networks* will be held on Thursday and Friday, August 2-3, 1990, during the Congress of the International Union for Pure and Applied Biophysics (IUPAB), July 29-August 3, 1990. The symposium is sponsored by the American Mathematical Society, the Society for Industrial and Applied Mathematics (SIAM), and the Society for Mathematical Biology (SMB).

The AMS-SIAM-SMB Committee on Mathematics in the Life Sciences serves as the Organizing Committee for the symposium. The committee at the time this topic was selected consisted of Jack D. Cowan (organizer), Michael C. Mackey, Marc Mangel, Hans G. Othmer, Richard E. Plant (chairman), and John Rinzel.

The theme of the symposium is *Neural networks*. There will be two morning sessions, one on Thursday and one on Friday, August 2 and 3, each session including three one-hour lectures.

For further information, contact the Symposium Conference Coordinator, AMS, P.O. Box 6887, Providence, RI 02940 or by electronic mail: BAV@MATH.AMS.COM.

Applications for the Landahl Travel Awards from the SMB for graduate students to attend this meeting should have been submitted by May 25. See the **Funding**

Information section (Landahl Travel Awards) of the April *Notices* for further details.

Program

Thursday, August 2, 9:30 a.m.

Chairman: Robert Miura, University of British Columbia
Neurodynamics. JACK D. COWAN, University of Chicago

Learning, networks, and approximation theory. T. A. POGGIO, Massachusetts Institute of Technology

Neural networks, information theory, and perception in animals and machines. RALPH LINSKER, IBM T. J. Watson Research Center

Friday, August 3, 9:30 a.m.

Chairman: John Rinzel, National Institutes of Health

Learning and generalization in multi-layered neural networks: A statistical analysis. D. RUMELHART, Stanford University

Growing and pruning neural networks: relation to statistical mechanics. ALAN LAPEDES, Los Alamos National Laboratory

Perspectives in computational neurobiology. TERRENCE J. SEJNOWSKI, Salk Institute

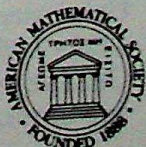
Positive Definite Unimodular Lattices with Trivial Automorphism Groups

Etsuko Bannai

(Memoirs of the AMS, Number 429)

In this book, the author proves that there exists a lattice with trivial automorphism group in every genus of positive definite unimodular \mathbb{Z} -lattices of rank m (with $m \geq 43$ for the odd unimodular case and $m \geq 144$ for the even unimodular case). Siegel's mass formulas for lattices (for both orthogonal and hermitian cases) are used in the proof. In addition, the author shows that, for those positive definite unimodular \mathbb{Z} -lattices in the given genus and of rank m , the ratio of the mass of classes with nontrivial automorphisms to the mass of all classes approaches 0 very rapidly as m increases. The book is intended for researchers and advanced graduate students in the areas of number theory and quadratic forms.

1980 *Mathematics Subject Classification*: 10
ISBN 0-8218-2491-0, LC 90-31824, ISSN 0065-9266
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Call For Topics For 1992 Conferences

Suggestions are invited from mathematicians, either singly or in groups, for topics of the various conferences that will be organized by the Society in 1992. The deadlines for receipt of these suggestions, as well as some relevant information about each of the conferences, are given below. An application form to be used when submitting suggested topic(s) for any of these conferences (except the Short Course Series) may be obtained by writing to the Meetings Department, American Mathematical Society, P.O. Box 6887, Providence, RI 02940, or telephoning 401-455-4146, or sending E-mail to MEET@MATH.AMS.COM.

Individuals willing to serve as organizers should be aware that the professional meetings staff in the Society's Providence office will provide full support and assistance before, during, and after each of these conferences. Organizers should also note that for all conferences, except Summer Research Conferences, it is required that the proceedings be published by the Society, and that proceedings of Summer Research Conferences are frequently published. A member of the Organizing Committee must be willing to serve as editor of the proceedings.

All suggestions must include (1) the names and affiliations of proposed members and the chairman of the Organizing Committee; (2) a one- to two-page description addressing the focus of the topic, including the importance and timeliness of the topic, and estimated attendance; (3) a list of the recent conferences in the same or closely related areas; (4) a tentative list of names and affiliations of the proposed principal speakers; and (5) a list of likely candidates who would be invited to participate and their current affiliations. Any suggestions as to sites and dates should be made as early as possible in order to allow adequate time for planning. However, proposers of conferences should know that, by action of the AMS Board of Trustees, the Meetings Department of the Society is responsible for the final selection of the site for each conference and for all negotiations with the host institution. Individuals submitting suggestions for the conferences listed below are requested to recommend sites or geographic areas which would assist the Meetings Department in their search for an appropriate site. In the case of Joint Summer Research Conferences in the Mathematical Sciences, a one-, two-, or three-week conference may be proposed.

1992 AMS Symposium in Pure Mathematics

The Symposium in Pure Mathematics has traditionally been conducted in the spring of even-numbered years in conjunction with a sectional meeting. The symposium can be held independently of a sectional meeting and serves to honor great accomplishments in mathematics. Proceedings are normally published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Topics in recent years have been:

1984 – *Pseudodifferential operators and Fourier integral operators with applications to partial differential equations*, organized by FRANÇOIS TREVES of Rutgers University

1987 – *The mathematical heritage of Herman Weyl*, organized by R. O. WELLS, JR. of Rice University.

1989 – *Complex geometry and Lie theory*, organized by JAMES CARLSON and C. HERBERT CLEMENS of the University of Utah.

Deadline For Suggestions: September 1, 1990

1992 AMS Summer Institute

Summer Institutes are intended to provide an understandable presentation of the state of the art in an active field of research in pure mathematics and usually extend over a three-week period. Dates for a Summer Institute must not overlap those of the Society's summer meeting, which at the time of this printing have not yet been determined. There should be a period of at least one week between them. Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Pure Mathematics*.

Current and recent topics:

1988 – *Operator theory/Operator algebras and applications*, organized by WILLIAM B. ARVESON of the University of California, Berkeley, and RONALD G. DOUGLAS of the State University of New York at Stony Brook.

1989 – *Several complex variables and complex geometry*, organized by STEVEN G. KRANTZ of Washington University.

1990 – *Differential geometry*, organized by ROBERT E. GREENE of the University of California, Los Angeles, and SHING-TUNG YAU of Harvard University.

Deadline For Suggestions: September 1, 1990

Call for Topics

1992 AMS-SIAM-SMB Symposium Some Mathematical Questions in Biology

This one-day symposium, sponsored jointly by the AMS, the Society for Industrial and Applied Mathematics (SIAM), and the Society for Mathematical Biology (SMB), is usually held in conjunction with the annual meeting of a biological society closely associated with the topic. Papers from the symposia are published by the AMS as volumes in the series *Lectures on Mathematics in the Life Sciences*.

Current and recent topics:

1987 - *Models in population biology*, organized by ALAN HASTINGS of the University of California, Davis.

1988 - *Dynamics of excitable media*, organized by HANS G. OTHMER of the University of Utah.

1989 - *Sex allocation and sex change: Experiments and models*, organized by MARC MANGEL of the University of California, Davis.

1990 - *Neural Networks*, organized by JACK D. COWAN of the University of Chicago.

Deadline For Suggestions: September 1, 1990

1992 AMS-SIAM Summer Seminar

The goal of the Summer Seminar, sponsored jointly by the AMS and the Society for Industrial and Applied Mathematics (SIAM), is to provide an environment and program in applied mathematics in which experts can exchange the latest ideas and newcomers can learn about the field. Proceedings are published by the AMS as volumes in the series *Lectures in Applied Mathematics*.

Current and recent topics:

1987 - *Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation*, organized by RANDOLPH BANK of the University of California, San Diego.

1988 - *Computational solution of nonlinear systems of equations*, organized by EUGENE ALLGOWER of Colorado State University.

1989 - *The mathematics of random media*, organized by WERNER KOHLER of Virginia Polytechnic Institute and State University and BENJAMIN WHITE of Exxon Research & Engineering Company.

1990 - *Vortex dynamics and vortex methods*, organized by CLAUDE GREENGARD of IBM T. J. Watson Research Center and CHRISTOPHER R. ANDERSON of the University of California, Los Angeles.

Deadline For Suggestions: September 1, 1990

1992 AMS-IMS-SIAM Joint Summer Research Conferences in the Mathematical Sciences

These conferences, jointly sponsored by the AMS, the Institute for Mathematical Statistics (IMS), and the Society for Industrial and Applied Mathematics (SIAM), are similar in structure to those held at Oberwolfach and represent diverse areas of mathematical activity, with emphasis on areas currently especially active. Careful attention is paid to subjects in which there is important interdisciplinary activity at present. Topics for the seventh series of one-week conferences, being held in 1990, are: *Probability models and statistical analysis for ranking data*; *Inverse scattering on the line*; *Deformation theory of algebras and quantization with applications to physics*; *Strategies for sequential search and selection in real time*; *Schottky problems*; and *Logic, local fields, and subanalytic sets*.

If proceedings are published by the AMS, they appear as volumes in the series *Contemporary Mathematics*.

Deadline For Suggestions: February 1, 1991

Call for Topics for 1992 AMS Short Course Series

The AMS Short Courses consist of a series of introductory survey lectures and discussions which take place over a period of one-and-one-half days during the Joint Mathematics Meetings held in January and August each year. Each theme is a specific area of applied mathematics or mathematics used in the study of a specific subject or collection of problems in one of the physical, biological, or social sciences, technology, or business.

Current and recent topics:

Combinatorial games (August 1990), *Mathematical questions in robotics* (January 1990), *Cryptology and computational number theory* (August 1989), *Matrix theory and applications* (January 1989), *Chaos and fractals* (August 1988), *Computational Complexity Theory* (January 1988). Proceedings are published by the Society as volumes in the series *Proceedings of Symposia in Applied Mathematics*, with the approval of the Editorial Committee.

Deadline for Suggestions: Suggestions for the January 1992 course should be submitted by **July 1, 1990**; suggestions for the August 1992 course should be submitted by **December 1, 1990**.

Submit suggestions to: James W. Maxwell, AMS, P.O. Box 6248, Providence, RI 02940.

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Electronic Bulletin Boards: The ability to post and read research announcements in the form of problems, solutions, and remarks. Items of professional interest such as parts of the *Notices of the AMS*, meeting schedules and agenda, Tables of Contents for selected publications, and new publications of the AMS will also be posted. Subscribers will be notified of new contributions.

On-line Conferencing: The ability for small groups (e.g., nominating committees, editorial committees, standing committees, research groups) to conduct business electronically in private conferences, asynchronously.

Mathematically Oriented Databases: The ability to search for correspondence or electronic mail addresses in a database comprised of the Combined Membership List (CML) of members of the AMS, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics, by indexed fields such as field of research interest or location.

Software Libraries: The ability to post and download mathematically oriented public domain software and courseware. T_EX software developed and supported by the AMS will be made available in this way. Each contribution will be described by an abstract and identify persons or organizations, if any, responsible for support. Contributions will be examined for their general appropriateness but are offered on an as-is basis. The AMS assumes no liability of any kind for software made available through e-MATH.

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Mathematical Sciences

Meetings and Conferences

THIS SECTION contains announcements of meetings and conferences of interest to some segment of the mathematical public, including *ad hoc*, local, or regional meetings, and meetings or symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. (Information on meetings of the Society, and on meetings sponsored by the Society, will be found inside the front cover.)

AN ANNOUNCEMENT will be published in *Notices* if it contains a call for papers, and specifies the place, date, subject (when applicable), and the speakers; a second full announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in each issue until it has been held and a reference will be given in parentheses to the month, year, and page of the issue in which the complete information appeared. Asterisks (*) mark those announcements containing new or revised information.

IN GENERAL, announcements of meetings and conferences held in North America carry only date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. Meetings held outside the North American area may carry more detailed information. In any case, if there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to the Editor of *Notices*, care of the American Mathematical Society in Providence.

DEADLINES for entries in this section are listed on the inside front cover of each issue. In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence SIX MONTHS prior to the scheduled date of the meeting.

EFFECTIVE with the 1990 volume of *Notices*, the complete list of Mathematical Sciences Meetings and Conferences will be published only in the September issue. In all other issues, only meetings and conferences for the twelve-month period following the month of that issue will appear. As new information is received for meetings and conferences that will occur later than the twelve-month period, it will be announced at the end of the listing in the next possible issue. That information will not be repeated until the date of the meeting or conference falls within the twelve-month period.

1990. IMACS International Workshop on Massively Parallel Methods in Computational Physics, Boulder, Colorado. (Sep. 1989, p. 914)

1990. IMACS Conference on Computer Aided Design, Yugoslavia. (Sep. 1989, p. 914)

1990. CWI-IMACS Symposia on Parallel Scientific Computing, Amsterdam, The Netherlands. (Feb. 1990, p. 216)

1990. Concentration Year on Stochastic Models, Statistical Methods, and Algo-

rithms in Image Analysis, Rome, Italy. (Apr. 1990, p. 491)

1990-1991. Academic Year Devoted to Operator Theory and Complex Analysis, Mittag-Leffler Institute, Djursholm, Sweden. (Dec. 1989, p. 1432)

July 1990

July 1990. AMS Summer Research Institute on Differential Geometry, University of California, Los Angeles, CA

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

July 1990. Two Week Computer Algebra Course at the Research Institute for Symbolic Computation, Linz, Austria. (May/Jun. 1990, p. 605)

16-August 3. Conference on "Enriching Discrete Mathematics Courses with Recent Developments", Univ. of Wyoming, Laramie, WY. (Apr. 1990, p. 495)

22-28. Konvexgeometrie, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

23-27. CADE 10 - Tenth International Conference on Automated Deduction, West Germany. (Feb. 1990, p. 223)

23-28. Fourth International Congress on Computational and Applied Mathematics, Leuven, Belgium. (Jan. 1990, p. 58)

23-August 4. Third Workshop on Stochastic Analysis, Silivri, Istanbul-Turkey. (Feb. 1990, p. 223)

24-August 2. A Summer School and Conference on Proof Theory, University of Leeds, Leeds, UK. (May/Jun. 1990, p. 606)

26-29. International Conference on New Trends in Geometric Function Theory and Applications, University of Madras, Madras, India. (Sep. 1989, p. 918)

29-August 4. Mechanik Und Algebraische Geometrie, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

30-August 4. The Fourth International Conference on Fibonacci Numbers and their Applications, Wake Forest University, Winston Salem, NC. (Nov. 1989, p. 1252)

31-August 2. Dynamics of Numerics and the Numerics of Dynamics, Bristol, England. (Nov. 1989, p. 1252)

August 1990

August 1990-May 1991. Special Year in Real Algebraic Geometry and Quadratic Forms, University of California, Berkeley, CA. (May/Jun. 1990, p. 607)

1-5. Topology Conference, University of Georgia, Athens, GA. (May/Jun. 1990, p. 607)

2-3. AMS-SIAM-SMB Symposium on Some Mathematical Questions in Biology, Neural Networks, Vancouver, Canada. (Mar. 1990, p. 330)

5-9. From Topology to Computation

Unity and Diversity in the Mathematical Sciences (in Honor of Professor Stephen Smale's 60th Birthday), Berkeley, CA. (Jan. 1990, p. 58)

5-11. **Mathematical Methods in Tomography**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

5-11. **International Conference on Approximation Theory**, Hungary. (Oct. 1989, p. 1097)

6-7. **AMS Short Course on Combinatorial Games**, Columbus, Ohio.

INFORMATION: M. Foulkes, AMS, P.O. Box 6248, Providence, RI 02940.

6-9. **1990 Joint Statistical Meetings**, Anaheim, CA. (Mar. 1988, p. 466)

6-10. **Singularities**, Honolulu, Hawaii. (Feb. 1990, p. 223)

*6-10. **Workshop on Geometric Methods and Finiteness Properties for Arithmetic Groups and Related Topics**, Bielefeld, Federal Republic of Germany.

PROGRAM: The Sonderforschungsbereich 343 and the Fakultät für Mathematik will support a five day workshop. It will focus on geometric methods and finiteness properties for arithmetic groups and related topics. It will offer the opportunity to meet and to explore topics of common interest to people working on buildings, analogous complexes, arithmetic groups and finiteness properties. There will be lectures and there will be time reserved for discussions.

INFORMATION: H. Abels, Fakultät für Mathematik, Postfach 8640, 4800 Bielefeld, F.R. Germany.

8-11. **Joint Mathematics Meetings**, Ohio State University, Columbus, OH. (including the summer meetings of the AMS, AWM, MAA and PME). This is the 75th Anniversary of the MAA.

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

8-11. **The Fifth KIT Mathematics Workshop**, Korea Institute of Technology, Taejeon, Korea. (Mar. 1990, p. 330)

11-14. **Crypto '90**, University of California, Santa Barbara, CA. (Apr. 1990, p. 495)

12-13. **Workshop on Using Technology to Enhance the Teaching and Learning of Calculus and Precalculus Mathematics**, The Ohio State University, Columbus,

OH. (Mar. 1990, p. 330)

12-18. **Algebraische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

12-18. **Pre-Congress Topology Conference**, University of Hawaii, Honolulu, HI. (Feb. 1990, p. 223)

13-16. **Alaska Conference, Quo Vadis, Graph Theory?**, University of Alaska, Fairbanks, AK. (Oct. 1989, p. 1097)

13-17. **Fifth International Conference on Hadronic Mechanics and Nonpotential Interactions**, University of Northern Iowa, Cedar Falls, Iowa. (Jul./Aug. 1989, p. 768)

13-17. **Eleventh IFAC World Congress**, Tallin, USSR. (Sep. 1989, p. 918)

13-17. **Algebraic Geometry and Analytic Geometry**, Tokyo, Japan. (Sep. 1989, p. 919)

13-17. **1990 International Conference on Parallel Processing**, Pennsylvania State University, University Park, PA. (Dec. 1989, p. 1438)

13-17. **NSF/CBMS Conference on Random Number Generation and Quasi-Monte Carlo Methods**, Univ. of Alaska, Fairbanks, AK. (Mar. 1990, p. 331)

*13-17. **Third International Colloquium on Group Theory**, Debrecen, Hungary.

INFORMATION: E. Szabó, Kossuth Lajos Univ., Mathematical Institute, Debrecen, Pf. 12, H-4010 Hungary.

13-18. **Institute of Mathematical Statistics Fifty-third Annual Meeting (jointly with the Second World Congress of the Bernoulli Society)**, Uppsala, Sweden. (Sep. 1989, p. 919)

13-18. **Tsukuba International Conference on Representations of Algebras and Related Topics**, University of Tsukuba, Japan. (Nov. 1989, p. 1253)

14-18. **The Asian Mathematical Conference 1990**, Hong Kong, China. (Sep. 1989, p. 919)

14-18. **Harmonic Analysis, Sendai 1990**, Tohoku University, Sendai, Japan. (Feb. 1990, p. 223)

14-18. **Zeta Functions in Geometry**, Tokyo Institute of Technology, Tokyo, Japan. (Feb. 1990, p. 223)

15-19. **International Conference on Knot Theory & Related Topics**, Naniwa-Kaikan Hotel, Osaka City, Japan. (Please note change in location from Apr. 1989, p. 497)

CG-9. 19-19. **International Conference on Com-**

mutative Algebra and Combinatorics, Nagoya University, Nagoya, Japan. (Feb. 1990, p. 224)

15-20. **Conference on Gaussian Random Fields (The Third Nagoya Lévy Seminar)**, Nagoya University, Nagoya, Japan. (Nov. 1989, p. 1253)

16-18. **SIGAL International Symposium on Algorithms**, Tokyo, Japan. (Oct. 1989, p. 1097)

16-19. **Current Topics in Operator Algebras**, Nara Ken-New Public Hall, Nara, Japan. (Feb. 1990, p. 224)

18-22. **The Second International Conference on Graph Theory**, Kanagawa, Japan. (Feb. 1990, p. 224)

19-20. **Inverse Problems in Engineering Sciences**, Osaka Institute of Technology, Osaka, Japan. (Feb. 1990, p. 224)

*19-24. **Third International Conference on the Teaching of Statistics**, Dunedin, New Zealand.

INFORMATION: ICOTS 3, Department of Mathematics and Statistics, University of Otago, P.O. Box 56, Dunedin, New Zealand.

19-25. **Mathematische Methoden Des VLSI-Entwurfs Und Des Distributed Computings**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

*19-25. **Anwendungen der Infinitesimalmathematik**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: S. Albeverio, Bochum; D. Laugwitz, Darmstadt; W.A.J. Luxemburg, Pasadena.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

20-24. **Second International Joint Conference of the ISSAC-90 and the AAECC-8**, Nihon University, Tokyo, Japan. (Feb. 1990, p. 224)

20-24. **International Conference on Combinatorics (ICC '90)**, Hefei, Anhui, China. (Apr. 1990, p. 495)

*20-24. **Bifurcation and Chaos: Analysis, Algorithms, Applications**, Würzburg, Federal Republic of Germany.

ORGANIZER: T. Küpper, Hannover; F. Schneider, Würzburg; R. Seydel, Würzburg; H. Troger, Wien.

INFORMATION: R. Seydel, Inst. für Angewandte Mathematik und Statis-

tik, Univ. Würzburg, Am Hubland, D-8700 Würzburg.

20-25. **Fifth Conference on Numerical Methods**, Miskolc, Hungary. (Jan. 1990, p. 59)

21-29. **The International Congress of Mathematicians 1990**, Kyoto, Japan. (Nov. 1988, p. 1389)

23-September 1. **Twenty-eighth International Symposium on Functional Equations**, Graz-Mariatrost, Austria. (Dec. 1989, p. 1438)

26-September 1. **Komplexe Analysis**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

27-31. **Eleventh Prague Conference on Information Theory, Statistical Decision Functions and Random Processes**, Praha, Czechoslovakia. (Jan. 1990, p. 59)

28-30. **IMACS European Simulation Meeting on Problem Solving by Simulation**, Esztergom, Hungary. (Mar. 1989, p. 316)

28-31. **Operations Research 1990, International Conference Operations Research**, Vienna, Austria. (Jul./Aug. 1989, p. 768)

29-31. **International Colloquium on Words, Languages, and Combinatorics**, Kyoto Sangyo University, Kyoto, Japan. (Feb. 1990, p. 224)

30-September 1. **International Symposium on the Semigroup Theory and its Related Fields**, Ritsumeikan University, Kyoto, Japan. (Feb. 1990, p. 224)

30-September 2. **International Symposium on Functional Differential Equations and Related Topics**, Kyoto Shigaku Kaikan (YOUANDI), Kyoto, Japan. (Feb. 1990, p. 224)

30-September 4. **International Conference on Potential Theory**, Nagoya, Japan. (May/Jun. 1989, p. 602)

30-September 4. **International Symposium on Computational Mathematics**, Matsuyama, Japan. (Feb. 1990, p. 224)

31-September 1. **Tokyo History of Mathematics Symposium 1990**, University of Tokyo, Tokyo, Japan. (Feb. 1990, p. 224)

31-September 2. **Conference on Representation Theories of Lie Groups and Lie Algebras**, Lake-Kawaguchi, Yamanashi, Japan. (Feb. 1990, p. 224)

31-September 4. **International Symposium on Functional Analysis and Related Topics**, Sapporo, Japan. (Feb. 1990, p. 225)

31-September 4. **General Topology and Geometric Topology Symposium**, University of Tsukuba, Japan. (Feb. 1990, p. 225)

September 1990

September/October 1990. **IMACS-GAMM Conference on Computer Arithmetic, Scientific Computation and Mathematical Modelling**, Bulgaria. (Sep. 1989, p. 919)

IMACS Symposium on Modelling and Simulation of Electrical Machines, ENSEM - Nancy, France. (May/Jun. 1989, p. 602)

2-7. **Twelfth International Conference on Nonlinear Oscillations**, Cracow, Poland. (Sep. 1989, p. 919)

2-7. **International Conference on Integral Equations and Boundary Value Problems**, Yantai University, Shandong, People's Republic of China. (Nov. 1989, p. 1253)

2-8. **Topologie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 497)

3-6. **Fourth Asian Logic Conference**, Tokyo, Japan. (Mar. 1989, p. 316)

3-7. **IMACS Symposium on Intelligent Models in Systems Simulation**, Brussels, Belgium. (Mar. 1989, p. 316)

3-7. **Représentation des Groupes et Analyse Complexe**, Marseille, France. (Jul./Aug. 1989, p. 768)

3-7. **International Conference on Dynamical Systems and Related Topics**, Nagoya University, Nagoya, Japan. (Feb. 1990, p. 225)

* 3-7. **Third International Symposium on Algebra and Number Theory (in honour of the 80th birthday of C. Arf)**, Silivri, Istanbul.

INFORMATION: C. Koc, A. Topuzoglu, Dept. of Math., Middle East Technical University, 06531 Ankara-Turkey; email: dogam@trmetu.bitnet.

3-8. **Physical Interpretations of Relativity Theory**, Imperial College, London, England. (Mar. 1990, p. 331)

* 3-8. **Stabilité Hydrodynamique Non-linéaire et Transition**, Nice, France.

INFORMATION: G. Jooss, Univ. de Nice, Labo. de math., Parc Valrose, F-06034 Nice.

8-12. **Neuronet-90: IMACS International Symposium on Neural Nets and Neural Computers**, Prague, Czechoslovakia. (Please note change from May/Jun. 1989, p. 602)

9-15. **Surgery and L-Theory**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 9-21. **Computer Algorithms for Solving Linear Algebraic Systems: The State of the Art**, Il Ciocco, Italy.

INFORMATION: E. Spedicato, Istituto Universitario, Dipartimento di Matematica, Via Salvechio 19, 24100 Bergamo, Italy.

9-22. **Computer Algorithms for Solving Linear Algebraic Equations: The State of the Art**, Il Ciocco, Castelvechio Pascoli, Tuscany, Italy. (May/Jun. 1990, p. 608)

10-12. **Second International Workshop on Advances in Robot Kinematics**, Linz, Austria. (Mar. 1990, p. 332)

10-14. **Mathematiker-Kongress**, Dresden, German Democratic Republic. (Jul./Aug. 1989, p. 769)

10-14. **Greco Calcul Formel**, Marseille, France. (Jan. 1990, p. 60)

10-14. **Real Analysis and Measure Theory**, Capri, Italy. (Mar. 1990, p. 332)

10-October 5. **School on Qualitative Aspects and Applications of Nonlinear Evolution Equations**, International Centre for Theoretical Physics, Trieste, Italy. (May/Jun. 1989, p. 602)

13-18. **The Marshall Hall 80th Birthday Conference on Coding Theory, Design Theory and Group Theory**, University of Vermont, Burlington, VT. (May/Jun. 1990, p. 608)

16-22. **Ankündigung der Jahrestagung 1990**, Universität Bremen, Bremen, W. Germany. (May/Jun. 1990, p. 609)

16-22. **Risikothorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

* 16-22. **Algebraic Methods in Computing Science**, University College of Swansea, Swansea, Wales.

PURPOSE: The objectives are (i) to educate research students, and university and industrial scientists, in mathematical theories to an advanced

level; and (ii) to introduce many current theoretical and applied research problems involving algebraic methods.

PROGRAM: The basic courses will be as follows: J.V. Tucker, Designing algebras; J.A. Goguen, Algebraic methods and theorem proving; H. Simmons, Equations and horn clauses: logic and model theory; J. Meseguer, Initial model semantics; J.W. Klop, Term rewriting; J. Baeten, Process algebra.

INFORMATION: B.C. Thompson, Computer Science Division, Dept. of Mathematics and Computer Science, Univ. College of Swansea, Swansea SA2 8PP, United Kingdom (email: cs-ben@uk.ac.swan.pyr).

17-21. **Atelier International de Theorie des Ensembles**, Marseille, France. (Jan. 1990, p. 60)

17-22. **DMV-Jahrestagung 1990**, Bremen, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)

19-21. **Third IMACS International Conference on Modelling and Simulation of Electrical Machines and Static Converters**, ENSEM - Nancy, France. (May/Jun. 1990, p. 609)

23-29. **Random Graphs and Combinatorial Structures**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

24-28. **Structure Galoisienne Arithmetique**, Marseille, France. (Jan. 1990, p. 60)

24-28. **IMACS-GAMM International Symposium on Computer Arithmetic, Scientific Computation and Mathematical Modelling - SCAN 1990**, Albena (near Varna), Bulgaria. (Feb. 1990, p. 225)

24-28. **International Symposium on Structures in Mathematical Theories**, San Sebastian, Espagna. (May/Jun. 1990, p. 609)

24-29. **Mathematical Modelling of Industrial Processes**, Tecnopolis, Bari. (Feb. 1990, p. 225)

24-30. **Ibero-American Conference**, Seville, Spain. (Apr. 1990, p. 497)

25-29. **International Symposium on Structures in Mathematical Theories**, San Sebastian, Spain. (Apr. 1990, p. 497)

27-29. **Topology and Geometry of Manifolds**, Bologna, Italy. (May/Jun. 1990, p. 609)

28-29. **Linear Algebra and its Applications**, Miami University, Oxford, OH. (Apr. 1990, p. 497)

30-October 6. **Diophantische Approximationen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

October 1990

* 1-4. **Third European Conference on Multigrid Methods**, Bonn, Federal Republic of Germany.

INFORMATION: Conference Secretariat, C. Harms, GMD, P.O. Box 1240, D-5205 Sankt Augustin 1.

1-5. **Organisations et Theorie des Jeux**, Marseille, France. (Jan. 1990, p. 60)

1-5. **Third Joint Europe/U.S. Short Course in Hypersonics**, RWTH Aachen Univ. of Technology, Federal Republic of Germany. (Mar. 1990, p. 332)

* 1-5. **Methodes D'Elements Finis Mixtes**, Roquencourt, France.

CHAIRMAN: J.E. Roberts, Roquencourt

INFORMATION: INRIA-Service des Relations Extérieures Bureau Cours et Journées, Domaine de Voluceau, B.P. 105, F-78153 Le Chesnay Cedex.

5-6. **Math-History Conference**, LaCrosse, WI. (Jan. 1990, p. 60)

5-7. **Workshop on Partial Differential Equations**, Cornell Univ., Ithaca, NY. (Mar. 1990, p. 332)

* 5-8. **Second Annual SUNYA Conference on Topology and Group Theory**, State University of New York at Albany.

PROGRAM: This conference will be held at the same facility as the 1989 conference and will again focus on low dimensional topology and combinatorial group theory. There will be hour lectures by the eight main speakers and a (noncompeting) program of shorter talks. Deadline for registration is September 14, 1990.

INVITED SPEAKERS: G. Baumslag, M. Bestvina, M. Culler, J. Howie, M. Lustig, J. Morgan, J. Stallings, K. Vogtmann.

INFORMATION: T. Turner, Department of Mathematics and Statistics, State University of New York at Albany, Albany, NY 12222; Bitnet: et968@albvm; 518-442-4610.

7-13. **Arbeitsgemeinschaft Mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

8-12. **Congres Franco-Sovietique de Programmation Mathematique**, Marseille, France. (Jan. 1990, p. 60)

14-20. **Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

15-19. **Modeles pour L'Analyse des Donnees Multidimensionnelles**, Marseille, France. (Jan. 1990, p. 60)

15-19. **Tercer Congreso Nacional de Matemáticas**, San José, Costa Rica. (Feb. 1990, p. 225)

18-21. **Sixteenth Annual Convention of the American Mathematical Association of Two-Year Colleges**, Dallas, TX. (May/Jun. 1990, p. 609)

* 19. **International Meeting on Nonlinear Dynamics in Mathematics & Science**, University of Massachusetts at Amherst.

PURPOSE: A chance to learn all about the field of nonlinear dynamics by having research lectures from international experts from U.S.S.R., England, Japan, and the U.S.

INVITED SPEAKERS: England: J.T. Stuart, J. Toland, L.E. Fraenkel; U.S.S.R.: V.I. Judovitch, O.A. Ladyhenskaya, A. Dubroischin; Japan: H. Matano; U.S.A.: H. McKean, A. Polyakov, R. Coifman, C. Jones, G. Knightly, C. Foias, R. Devaney.

INFORMATION: Center for Applied Mathematics, University of Massachusetts, Amherst, MA 01003, Attn: C. Boron, Coordinator; 413-545-0267.

19-20. **Nineteenth Midwest Conference on Differential and Integral Equations**, Univ. of Missouri-Rolla, Rolla, MO. (Apr. 1990, p. 498)

19-20. **Twelfth Midwest Probability Colloquium**, Northwestern University, Evanston, IL. (May/Jun. 1990, p. 610)

* 19-20. **1990 Mathematical Sciences Department Chairs Colloquium**, Arlington, VA.

PROGRAM: The theme of the 1990 colloquium is "Departmental Outreach." The program is designed to provide information chairs may use to foster departmental interaction with various constituent groups and external agencies. The program includes: a report by the Committee on the Mathematical Sciences in the Year 2000, panels on women and minorities in mathematics, and statistics in mathematics departments.

INFORMATION: Board on Mathematical Sciences, National Research Council, 2101 Constitution Avenue, N.W., Room NAS 312, Washington, DC 20418.

20-21. **Eastern Section**, University of Massachusetts at Amherst, Amherst, MA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

21-27. **Mathematische Methoden In Der Robotik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

21-27. **Arithmetik der Körper**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

21-27. **International Functional Analysis Meeting on the Occasion of the Sixtieth Birthday of Professor M. Valdivia**, Peñíscola, Spain. (May/Jun. 1990, p. 610)

* 21-27. **Algebraic and Combinatorial Problems in Multivariate Approximation Theory**, Oberwolfach, Federal Republic of Germany.

CHAIRMAN: W. Dahmen, Berlin; A. Dress, Bielefeld.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

* 22-24. **Thirty-first Annual Foundations of Computer Science**, St. Louis, MO.

INFORMATION: C. Papdimitriou, Dept. of Computer Science, Univ. of California, San Diego, La Jolla, CA 92093; 619-534-2086.

22-25. **Fifth Jerusalem Conference on Information Technology (JCIT-5)**, Jerusalem, Israel. (Jan. 1990, p. 60)

* 22-26. **Journées de Probabilités**, Marseille, France.

ORGANIZER: J. Azéma, Paris; M. Yor, Paris.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

* 24-26. **Fifth Annual Conference of the Midwest College Learning Center Association - Breaking Barriers to Learning**, Milwaukee, WI.

PROGRAM: Keynote speakers - S. To-

bias, Math Anxiety; M. Alvarez, Thinking Visually.

INFORMATION: J. Dvorak, MCLCA Conference Chair, UW-Milwaukee DLSEO P.O. Box 413, Milwaukee, WI 53201; 414-229-5672.

26-27. **Statistical Mechanics at the 45th Parallel: Fourth Annual Meeting**, Université de Montréal, Canada. (Feb. 1990, p. 226)

26-28. **Twenty-first U.S.L. Mathematics Conference (Algebra)**, University of Southwestern Louisiana, Lafayette, LA. (May/Jun. 1990, p. 610)

* 28-November 1. **North American Conference on Logic Programming 1990 (NACL P '90)**, Austin, TX.

INFORMATION: C. Zaniolo, 3500 W. Balcones Center Dr., Austin, TX 78759; 512-338-3442.

28-November 3. **Mathematical Economics**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

29-November 2. **Trieste Conference on Integrable Systems**, Trieste, Italy. (Jan. 1990, p. 61)

29-November 2. **Algorithmes Paralleles et Architectures Nouvelles**, Marseille, France. (Jan. 1990, p. 61)

29-November 2. **The International Conference "D-Modules and Microlocal Geometry"**, Lisbon, Portugal. (Mar. 1990, p. 333)

29-November 16. **Workshop on Mathematical Ecology**, Trieste, Italy. (Jan. 1990, p. 61)

31-November 3. **Latinamerican Seminar on Applications of Mathematics and Computer Science to Biology**, La Habana, Cuba. (Feb. 1990, p. 226)

November 1990

2-3. **Central Section Meeting of the AMS**, University of North Texas, Denton, TX.

INFORMATION: W. Drady, AMS, P.O. Box 6248, Providence, RI 02940.

4-10. **Wahrscheinlichkeitsmaße auf Gruppen**, Oberwolfach, Federal Republic of Germany. (Oct. 1989, p. 1098)

* 5-7. **Mathematiques Informatique**, Marseille, France.

ORGANIZER: J. M. Bae, Montpellier

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

* 5-8. **Second SIAM Conference on Linear Algebra in Signals, Systems & Controls**, San Francisco, CA. (Please note date change from Sep. 1989, p. 920)

6-7. **1990 ACM Conference on Critical Issues**, Arlington, VA. (Apr. 1990, p. 498)

9-11. **Third Annual Conference on Technology in Collegiate Mathematics**, The Ohio State Univ., Columbus, OH. (Mar. 1990, p. 333)

10. **Differential Geometry Day**, Eastern Illinois University, Charleston, IL. (Apr. 1990, p. 498)

10-11. **Far Western Section**, University of California, Irvine, CA.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

12-16. **Supercomputing '90**, New York, NY. (Sep. 1989, p. 920)

12-16. **Workshop on Representations of Reductive Groups over Finite Fields**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)

* 12-16. **Supercomputing '90**, New York, NY.

INFORMATION: J.L. Martin, IBM T.J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY 10598; 914-945-3285.

16-17. **Tenth Annual Southeastern-Atlantic Regional Conference on Differential Equations**, Virginia Polytechnic Institute and State University, Blacksburg, VA. (May/Jun. 1990, p. 610)

18-24. **Komplexitätstheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

19-22. **Huygens' Principle 1690-1990. Theory and Applications**, Scheveningen, The Hague, The Netherlands. (May/Jun. 1990, p. 610)

* 21-23. **Colloque Franco-Belge de Statistique**, Marseille, France.

ORGANIZER: C. Deniau, Marseille.
INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

25-28. **Mathematics and its Applications**, University of Bahrain, State of Bahrain. (May/Jun. 1990, p. 610)

- 25-December 1. **Stochastische Approximation Und Optimierungsprobleme In Der Statistik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)
- 25-December 1. **Lineare Modelle und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Jul./Aug. 1989, p. 769)
- 26-30. **Seminaire Sud-Rhodanien de Geometrie Differentielle**, Marseille, France.

ORGANIZER: L. Niglio, Avignon.

INFORMATION: A. Zeller-Meier, CIRM, Luminy, Case 916, F-13288 Marseille Cedex 9.

December 1990

- 2-8. **Multigrid Methods**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)
- 3-5. **First International Symposium on Uncertainty and Analysis: Fuzzy Reasoning, Probabilistic Methods and Risk Management**, College Park, Maryland. (Oct. 1989, p. 1098)
- 3-7. **Sixteenth Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, Palmerston North, New Zealand. (Feb. 1990, p. 226)
- 3-7. **SINO-JAPANESE Joint Seminar on Nonlinear PDEs with Emphasis on Reaction-Diffusion Aspects.**, Taipei, Taiwan. (Jan. 1990, p. 61)
- 3-7. **Workshop on General Group Representation Theory**, Mathematical Sciences Research Institute, Berkeley, CA. (Jan. 1990, p. 61)
- 9-15. **Allgemeine Ungleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)
- *11-12. **Integral Valued Polynomials Encounter**, CIRM, Marseille, France. (Please note additional Invited Speakers from May/Jun. 1990, p. 611)

INVITED SPEAKERS: J. Brewer, Florida; M. Fontana, Rome; D. Lantz, Hamilton; A. Micali, Montpellier.

- 11-13. **Third Joint IFSA-EC and EURO-WG Workshop on Fuzzy Sets**, Visegrád, Hungary. (May/Jun. 1990, p. 611)
- 15-19. **Curves and Surfaces: An Algorithmic Viewpoint**, Kent State Univ., Kent, OH. (Apr. 1990, p. 499)
- 16-22. **Mathematische Logik**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

- 17-21. **Non-linear Dispersive Wave Systems**, Univ. of Central Florida, Orlando, FL. (Apr. 1990, p. 499)

- 25-January 1. **Lineare Modelle Und Multivariate Statistische Verfahren**, Oberwolfach, Federal Republic of Germany. (Apr. 1989, p. 498)

- *27-31. **Holiday Symposium on Recent Developments in Homotopy Theory**, New Mexico State Univ., Las Cruces, NM.

PROGRAM: This year's symposium is focused on recent developments in homotopy theory. There will be a series of ten lectures, two each day, by D.C. Ravenel of the Univ. of Rochester. There will be additional sessions for contributed papers, research ideas, and discussion. Some support may be available for a limited number of participants.

INFORMATION: R.J. Wisner, Homotopy Theory Symposium, Dept. of Mathematical Sciences, New Mexico State Univ., Box 30001, Las Cruces, NM 88003-0001; 505-646-3901.

- *1991. **IMACS Symposium on Parallel and Distributed Computing in Engineering Systems**, Athens, Greece.

INFORMATION: S. Tzafestas, National Technical University of Athens, Division of Computer Science, Dept. of Electrical Engineering, 157 73 Zographou, Athens, Greece.

- Spring 1991. **IMACS International Symposium on Iterative Methods in Linear Algebra**, Brussels Free Univ., Brussels, Belgium. (Mar. 1990, p. 334)

January 1991

- 6-12. **Automorphe Formen und Anwendungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

- *7-9. **SIAM Workshop on Automatic Differentiation of Algorithms: Theory, Implementation, and Application**, Breckenridge, CO.

ORGANIZER: A. Griewank, Argonne Nat'l. Lab.

INFORMATION: SIAM Conference Coordinator, Dept. CC0590, 3600 University City Science Ctr., Philadelphia, PA 19104-2688; 215-382-9800; Fax 215-382-9899.

Fax 215-386-7999; email: siamconfs@wharton.upenn.edu.

- 7-10. **Sixth Caribbean Conference in Combinatorics and Computing**, University of the West Indies, St. Augustine, Trinidad. (Jan. 1990, p. 61)

- 13-19. **Combinatorial Optimization**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

- 14-15. **AMS Short Course on "Probabilistic Combinatorics and its Applications"**, San Francisco, CA.

INFORMATION: D. Plante, AMS, P.O. Box 6248, Providence, RI 02940.

- 16-19. **Joint Mathematics Meetings**, San Francisco, CA. (including the annual meetings of the AMS, AWM, MAA, and NAM)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

- 20-26. **Spektraltheorie Singulärer Gewöhnlicher Differentialoperatoren**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

- 27-February 2. **Harmonische Analyse und Darstellungstheorie Topologischer Gruppen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

- *28-30. **Second ACM-SIAM Symposium on Discrete Algorithms**, San Francisco, CA.

PURPOSE: This conference is designed for computer scientists, engineers, and mathematicians interested in the use, design and analysis of algorithms, with special emphasis on questions of efficiency.

ORGANIZER: A. Aggarwal, IBM T.J. Watson Research Ctr.

INVITED SPEAKERS: R.L. Graham, AT&T Bell Labs.; E.S. Lander, Whitehead Institute for Biomedical Research and Harvard Univ.; L. Lovasz, Lorand Eotvos Univ., Hungary and Princeton Univ.

CALL FOR PAPERS: Papers will be selected for presentation based on extended abstracts. Authors wishing to submit a paper should send 11 copies of an extended abstract (not a full paper) to SIAM by July 30, 1990. INFORMATION: SIAM Conference Coordinator, Dept. CC0590, 3600 University City Science Ctr., Philadelphia, PA 19104-2688; 215-382-9800; Fax 215-382-9899.

215-386-7999; email:
siamconfs@wharton.upenn.edu.

February 1991

3-9. **Konstruktive Methoden in der Komplexen Analysis**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

10-16. **Endlichdimensionale Lie-Algebren**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

10-16. **Affine Differentialgeometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 499)

* 17-23. **Experimentelle, Insbesondere Computergraphische Methoden in der Mathematik**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H.-O. Peitgen, Bremen; U. Pinkall, Berlin.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

* 17-23. **Krein Spaces and Applications to Differential Operators**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: L. de Branges, West Lafayette; H. Langer, Regensburg; R. Mennicken, Regensburg.

24-March 2. **Medical Statistics: Statistical Models for Longitudinal Data**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

25-March 1. **IEEE Computer Society COMPCON Spring '91**, San Francisco, CA. (Jan. 1990, p. 62)

March 1991

3-9. **Partielle Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

5-7. **Association for Computing Machinery 1991 Computer Science Conference**, San Antonio Convention Center, San Antonio, TX. (May/Jun. 1990, p. 611)

7-8. **Twenty-second ACM SIGCSE Technical Symposium on Education in the Computing Sciences**, San Antonio, TX. (May/Jun. 1990, p. 612)

7-10. **International Conference on Differential Equations**, Cadi Ayyad University, Marrakech, Morocco. (May/Jun. 1990, p. 612)

10-16. **Mathematische Stochastik**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

* 11-15. **NSF-CBMS Regional Research Conference on Nonlinear Dispersive Wave Systems**, University of Central Florida, Orlando, FL. (Please note changes from May/Jun. 1990, p. 612)

PROGRAM: Professor Benjamin's lectures will cover a broad range of topics connected with nonlinear waves propagation in continuum mechanics. A partial outline of the ten, one-hour lectures he will deliver is as follows: examples of nonlinear dispersive waves, exact and approximate representation of physical systems, water waves, internal waves, vortex motions; Hamiltonian structure, symmetries and conservation laws, practical interpretations; canonical derivation of approximate equations, long-wave models, envelope equations; variational principles for group-invariant solutions, prospects for variational existence theories; stability and instability of wave motions; effects of dispersion on otherwise discontinuous solutions of nonlinear wave equations; theory of vortex-breakdown phenomenon, relation between axisymmetric and symmetry-breaking types; review of outstanding problems. Additional invited lectures by other leading experts will also be featured, and ample opportunity is planned for informal discussion as well.

13-15. **IMACS Workshop on Decision Support Systems and Qualitative Reasoning**, LAAS-Toulouse, France. (May/Jun. 1990, p. 612)

16-17. **Central Section**, Indiana University, South Bend, IN.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

17-23. **Elementare und Analytische Zahlentheorie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

17-24. **Sixth International Conference on Geometry**, University of Haifa, Israel. (May/Jun. 1990, p. 612)

21-23. **Sixth S.E.A. Meeting, Southeastern Approximation Theorists Annual Meeting**, Memphis State Univ., Memphis, TN. (Mar. 1990, p. 334)

22-23. **Southeastern Section**, University of South Florida, Tampa, FL.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

22-24. **Fifth SIAM Conference on Parallel Processing for Scientific Computing**, Houston, TX. (Mar. 1990, p. 334)

24-30. **Gewöhnliche Differentialgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

* 25-27. **Fifth SIAM Conference on Parallel Processing for Scientific Computing**, Houston, TX.

ORGANIZER: D. Sorensen, Rice Univ.

INFORMATION: SIAM Conference Coordinator, Dept. CC0590, 3600 University City Science Ctr., Philadelphia, PA 19104-2688; 215-382-9800; Fax 215-386-7999; email: siamconfs@wharton.upenn.edu.

* 25-28. **International Conference on Mathematical Linguistics - ICML '91**, Barcelona, Spain.

PROGRAM: ICML intends to become an open forum for the presentation and discussion of current research on mathematical models of natural language. ICML '91 aims to show the actual state-of-the-art in the different fields of the discipline. The language of the Congress is English.

CALL FOR PAPERS: Papers for a presentation in 30 minutes are accepted. Authors must send a single copy of an abstract (1 page). Abstract submission deadline: September 6, 1990. Notification deadline of acceptance: September 20, 1990. Final text deadline: December 23, 1990.

INFORMATION: C.M. Vide, Univ. de Barcelona, Facultat de Filologia, Secció de Lingüística General, Gran Via de les Corts Catalanes, 585, 08007 Barcelona, Spain; Fax: 93-302.59.47 (from Spain); 34-3-302.59.47 (from another country).

31-April 6. **Arbeitsgemeinschaft mit Aktuellem Thema**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

April 1991

2-4. **IMACS International Symposium on Iterative Methods in Linear Algebra**

bra, Brussels Free Universities, Belgium.
(May/Jun. 1990, p. 612)

7-13. **Algebraische Gruppen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

8-12. **Seventh International Conference on Data Engineering**, Kobe, Japan. (Apr. 1990, p. 500)

8-12. **NASECODE VII, The Seventh International Conference on the Numerical Analysis of Semiconductor Devices and Integrated Circuits**, Copper Mountain, Colorado. (May/Jun. 1990, p. 612)

10-12. **Fourth International Conference on Rewriting Techniques and Applications (RTA-91)**, Como, Italy.

SPONSORS: State University of Milan in cooperation with the European Association for Theoretical Computer Science, the IEEE Technical Committee on Mathematical Foundations of Computer Science, and the Association for Computing Machinery-SIGACT and SIGART.

CONFERENCE TOPICS: Term rewriting systems, conditional and typed rewriting, completion procedures, unification and matching algorithms, algebraic specification, rewrite-based functional and equational programming languages, rewrite-based theorem proving, graph rewriting and graph grammars, higher-order systems, rewriting techniques in symbolic and algebraic computation, Thue systems, studies of combinatorial structures using rewriting techniques, combinatorial rewriting in computer science, mathematics, and other areas of application.

CALL FOR PAPERS: Papers presenting original research on rewriting techniques and applications are being sought. Original research papers are solicited. All submissions should be clearly written in English and include references and comparisons with related work (where appropriate). Each submission should include ten (10) copies of an extended abstract or a full draft paper of at most 4,000 words (e.g., approximately 10 - 15 double spaced pages).

INFORMATION: R.V. Book, RTA-91, Theoretische Informatik, Institut für Informatik, Univ. Würzburg, Am Hubland, D-8700 Würzburg, West Germany.

14-20. **Brauer Groups and Representations**

tation Theory of Finite Groups, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 500)

* 21-27. **Numerical Linear Algebra**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: G.H. Golub, Stanford; W. Niethammer, Karlsruhe; R.S. Varga, Kent.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

* 23-26. **Mathematical and Numerical Aspects of Wave Propagation Phenomena**, Strasbourg, France.

CONFERENCE TOPICS: Waves in homogeneous, heterogeneous, layered or random media; Guided waves, surface waves, scattering, resonances; Inverse problems, homogenization, control theory; Ray methods, paraxial methods, asymptotic analysis, absorbing boundary conditions; FMD, FEM; Spectral methods, integral equations, multigrid methods, domain decomposition; Vector and parallel processing.
INFORMATION: INRIA, Service des Relations Extérieures, Domaine de Voluceau - BP 105 - Rocquencourt, 78153 Le Chesnay Cedex, France.

28-May 4. **Deductive Systems**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

May 1991

May/June 1991. **IMACS Workshop on Decision Support Systems and Qualitative Reasoning**, Toulouse, France. (Mar. 1990, p. 334)

* 5-11. **Darstellungstheorie Endlich-Dimensionaler Algebren**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: V. Dlab, Ottawa; C.M. Ringel, Bielefeld.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

* 6-8. **Fifth SIAM International Symposium on Domain Decomposition Methods for Partial Differential Equations**, Norfolk, VA.

ORGANIZER: R.G. Voigt, ICASE-CC-0. In Public Domain, Gurukul Kangri Collection, Haridwar

INFORMATION: SIAM Conference Coordinator, Dept. CC0590, 3600 University City Science Ctr., Philadelphia, PA 19104-2688; 215-382-9800; Fax 215-386-7999; email: siamconfs@wharton.upenn.edu.

7-10. **IMACS Symposium on Modelling and Simulation of Control Systems**, Casablanca, Morocco. (Mar. 1990, p. 334)

* 7-14. **Singapore Number Theory Workshop**, National Univ. of Singapore, Kent Ridge, Singapore.

ORGANIZING COMMITTEE: T.A. Peng (Chair), S.L. Ma (Secretary), T.S. Chew (Treasurer), K.H. Leung (Programme), R.K.S. Poh (Accommodation).

INVITED SPEAKERS AND TOPICS: B.H. Gross (Harvard Univ.), Elliptic curves and modular forms; W.M. Schmidt (Univ. of Colorado), Diophantine equations; J.-P. Serre (Collège de France), Sieves.

INFORMATION: S.L. Ma, Secretary, Singapore Number Theory Workshop, Dept. of Math., Nat'l. Univ. of Singapore, Kent Ridge, Singapore 0511, Republic of Singapore; email: matmasl@nusvm.bitnet.

12-18. **Nichtlineare Evolutionsgleichungen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

13-17. **Conference in Harmonic Analysis in Honor of E.M. Stein**, Princeton University, Princeton, NJ. (Mar. 1990, p. 334)

19-25. **Differentialgeometrie im Grossen**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

22-24. **Second International Conference on Algebraic Methodology and Software Technology**, (AMAST), Iowa City, IA. (Apr. 1990, p. 501)

26-June 1. **Optimalsteuerung und Variationsrechnung-Optimal Control**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

* 29-June 1. **Eighth Biennial Conference of the Association of Christians in the Mathematical Sciences**, Wheaton College, Wheaton, IL.

INVITED SPEAKER: J. Richards, Brown Univ.

CALL FOR PAPERS: Abstract deadline for other papers: Nov. 15, 1990.

INFORMATION: R.L. Brabenec, Wheaton College, Wheaton, IL 60187; 708-260-3869.

June 1991

June 1991. **Third IMACS International Symposium on Computational Acoustics**, Harvard Univ., Cambridge, MA. (Mar. 1990, p. 334)

2-8. **Diskrete Geometrie**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

3-7. **1991 Annual Meeting of the Statistical Society of Canada**, Toronto, Ontario, Canada. (Mar. 1990, p. 334)

9-15. **Singuläre Störungsrechnung**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

10-14. **Bernoulli Society Twentieth Conference on Stochastic Processes and their Applications**, Nahariya, Israel. (Nov. 1989, p. 1254)

* 13-15. **Western Sectional Meeting**, Portland State University, Portland, Oregon.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

17-21. **1991 International Symposium on the Mathematical Theory of Networks and Systems (MTNS-91)**, International Conference Center Kobe, Kobe, Japan. (Nov. 1989, p. 1254)

17-21. **European Conference on Elliptic and Parabolic Problems**, Pont à Mousson, France. (May/Jun. 1990, p. 613)

* 23-29. **Mathematische Methoden des VLSI-Entwurfs und des Distributed Computing**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: M.J. Fischer, New Haven; M. Fontet, Paris; G. Hotz, Saarbrücken. INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

* 26-28. **Third IMACS International Symposium on Computational Acoustics**, Harvard University, Cambridge, MA.

CHAIRMEN: D. Lee (Naval Underwater Systems Center), A. Robinson (Harvard Univ.), R. Vichnevetsky (Rutgers Univ.).

CONFERENCE TOPICS: State-of-the-art developments in computational as-

pects of 3-dimensional problems in long-range propagations, scattering, fluid-elastic and bottom interactions, ocean-acoustic model interface; significant developments in the application of effective methods to solve acoustic problems; accuracy and capability issues in model development; time-domain computations; solutions to acoustic problems by supercomputers.

INFORMATION: D. Lee, Code 3122, Naval Underwater Systems Center, New London, CT 06320; 203-440-4438.

30-July 6. **Elliptische Operatoren auf Singulären und Nichtkompakten Mannigfaltigkeiten**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 501)

July 1991

1-5. **The Mathematics of Nonlinear Systems**, University of Bath, United Kingdom. (Jan. 1990, p. 62)

* 2-5. **European Control Conference**, Grenoble, France.

CHAIRMAN: I.D. Landau, Grenoble.

INFORMATION: Secrétariat de la Conférence, GR Automatique/ENSIEG, B.P. 46, F-38402 Saint-Martin-d'Hères.

* 7-13. **Computational Number Theory**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H.W. Lenstra Jr., Berkeley; M. Pohst, Düsseldorf; H.G. Zimmer, Saarbrücken.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

8-12. **Second International Conference on Industrial and Applied Mathematics**, Washington, DC. (Apr. 1990, p. 501)

8-14. **ICOR '91 International Conference on Radicals**, Szekszárd, Hungary. (Apr. 1990, p. 502)

14-20. **Dynamische Systeme**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 502)

15-17. **Fifth IFAC/IMACS Symposium on Computer Aided Design in Control and Engineering Systems**, Swansea, UK. (Mar. 1990, p. 334)

* 21-27. **Halbgruppentheorie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: J.M. Howie, St. Andrews; W.D. Munn, Glasgow; H.J. Weinert, Clausthal-Zellerfeld.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

22-26. **Thirteenth IMACS World Congress on Computation and Applied Mathematics**, Trinity College, Dublin University, Dublin, Ireland. (Apr. 1990, p. 502)

28-August 3. **Gruppen und Geometrien**, Oberwolfach, Federal Republic of Germany. (Apr. 1990, p. 502)

August 1991

3-7. **Interamerican Conference on Mathematics Education**, Univ. of Miami, Coral Gables, FL. (Apr. 1990, p. 502)

* 4-10. **Effiziente Algorithmen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: K. Melhorn, Saarbrücken; R.E. Tarjan, Princeton.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

* 5-8. **ICMI-China Regional Conference on Mathematics Education**, Beijing, China.

PURPOSE: The conference provides a forum for mathematics educators to present and discuss their ideas, views, and findings and to set a direction for establishing international links and future research. The conference theme is sufficiently general in order to provide participants an opportunity to address several issues in mathematics education, with a slant towards East Asia.

SPONSOR: International Commission on Mathematical Instruction and several Chinese mathematics/mathematics education organizations.

ORGANIZER: Beijing Normal Univ., Beijing, China.

INTERNATIONAL PROGRAM COMMITTEE: Z. Shanji (China), D. Ersheng (China), H. Fujita (Japan), L.P. Yee (Singapore), J.P. Becker (U.S.A.), M. Niss (Denmark), B.F. Nebres (Philippines), M.F. Newman (Australia).

INVITED SPEAKERS: C. Deschamps

(France), L.A. Steen (U.S.A.), H. Fujita and F. Terada (Japan), Z. Shanji and D. Ersheng (China).

CALL FOR PAPERS: There will be twenty-minute sessions for contributed papers and also poster sessions. The title and abstract should be submitted as soon as possible to be considered for inclusion. Official language is English.

INFORMATION: Z. Shanji, Dept. of Math., Beijing Normal Univ., Beijing 100875, China or L. P. Yee, Dept. of Mathematics, National Univ. of Singapore, Kent Ridge, Singapore 0511, Republic of Singapore; email matleegy@nusvm.bitnet. The Second Announcement will be sent after the IPC meeting in September 1990.

*5-9. **Fourteenth International Symposium on Mathematical Programming**, Amsterdam, The Netherlands.

PROGRAM: This is the triennial scientific meeting of the Mathematical Programming Society. The meeting will offer invited and contributed lectures in parallel sessions. In addition, computer demonstrations and survey lectures highlighting developments of current interest are planned. Also, the George B. Dantzig Prize, the Fulkerson Prizes, the Orchard-Hays Prize, and the A.W. Tucker Prize will be awarded.

CONFERENCE TOPICS: Linear, integer, mixed-integer programming; interior-point and path-following algorithms; nonlinear, nonconvex, nondifferential, global optimization; Complimentary and fixed point theory; Dynamic and stochastic programming, optimal control; Game theory and multicriterion optimization; Combinatorial optimization, graphs and networks, matroids; Computational complexity; Approximative methods, heuristics; Computational geometry, VLSI-design; Implementation and evaluation of algorithms and software; Large-scale mathematical programming; Parallel computing in mathematical computing; Expert, interactive, and decision support systems; Mathematical programming on personal computers; Teaching in mathematical programming; Applications of mathematical programming in industry, government, economics, management, fi-

nance, transportation, engineering, energy, environment, agriculture, sciences and humanities.

CALL FOR PAPERS: Papers on all theoretical, computational and practical aspects of mathematical programming are welcome. The presentation of very recent results is encouraged. Deadline for submission of titles and abstracts: June 1, 1991.

INFORMATION: 14th International Symposium on Mathematical Programming, Paulus Potterstraat 40, 1071 DB Amsterdam, The Netherlands, tel: +31-20-752120; telefax: +31-20-6628136; telex: 10761 omega.nl; email: ismp@swivax.uucp or ismp@swi.psy.uva.nl.

8-11. **Joint Mathematics Meetings**, University of Maine, Orono, ME. (including the summer meetings of the AMS, AWM, MAA, and PME)

INFORMATION: H. Daly, AMS, P.O. Box 6248, Providence, RI 02940.

19-22. **1991 Joint Statistical Meetings**, Atlanta, GA. (Mar. 1988, p. 466)

*11-17. **European Young Statisticians Meeting**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: G. Alsmeyer, Kiel.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

*18-24. **The Navier-Stokes Equations: Theory and Numerical Methods**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: J. Heywood, Vancouver; K. Masuda, Tokyo; R. Rautmann, Paderborn; V.A. Solonnikov, Leningrad.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

*18-September 4. **Twenty-first Summer Ecole de Calcul des Probabilités**, Saint Flour, France.

CHAIRMEN: D.A. Dawson, Ottawa; B. Maisonneuve, Grenoble; J. Spencer, New York.

INFORMATION: P.L. Hennequin, Mathématiques Appliquées, F-63177 Aubière Cedex.

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*21-25. **The International Conference on the Theory of Rings, Algebras, and Modules in Honor of A.I. Shirshov**, Barnaul, U.S.S.R.

CONFERENCE TOPICS: Associative algebras, rings, and modules (including representations of groups and algebras, homological algebra); Nonassociative rings and algebras (including Lie algebras, superalgebras); Ring and module methods in geometry (including algebraic geometry), analysis (including functional analysis), mathematical logic, and combinatorial algebra.

INFORMATION: Organizing Committee, International Conference on Ring Theory in Memory of A.I. Shirshov, Institute of Mathematics, Novosibirsk, 630090, U.S.S.R.

*25-31. **Klassifikation Komplex-Algebraischer Varietäten**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: K. Hulek, Bayreuth; Th. Peternell, Bayreuth; M. Schneider, Bayreuth.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

September 1991

*1-7. **Topologie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: M. Kreck, Mainz; A. Ranicki, Edinburgh; L. Siebenmann, Paris.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

*8-14. **Niedrigdimensionale Topologie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: M. Boileau, Toulouse; K. Johannson, Knoxville; H. Zieschang, Bochum.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

*8-14. **Knoten und Verschlingungen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: U. Koschorke, Siegen; J. Levine, Waltham.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 15-20. **DMV-Jahrestagung 1991**, Bielefeld, Federal Republic of Germany.

ORGANIZER: J. Mennicke.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 15-21. **Geometrie der Banachräume**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: H. König, Kiel; J. Lindenstrauss, Jerusalem; A. Pelczynski, Warschau.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 22-28. **Nonlinear and Random Vibrations**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: L. Arnold, Bremen; W. Schiehlen, Stuttgart; W. Wedig, Karlsruhe.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 29-October 5. **Kombinatorik Geordneter Mengen**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: M. Aigner, Berlin; R. Wille, Darmstadt.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

October 1991

- * 6-12. **Arbeitsgemeinschaft mit Aktuellem Thema (wird in den Mitteilungen der DMV Heft 3/1991 bekanntgegeben)**, Oberwolfach, Federal Republic of Germany.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 13-19. **Geometrie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: V. Bangert, Bern; U. Pinkall, Berlin.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 20-26. **C*-Algebren**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: J. Cuntz, Heidelberg; U. Haagerup, Odense; L. Zsidó, Stuttgart.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

November 1991

- * 3-9. **Mengenlehre**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: M. Magidor, Jerusalem; E.-J. Thiele, Berlin.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 9-10. **Western Sectional Meeting**, University of California, Santa Barbara.

INFORMATION: W. Drady, American Mathematical Society, P.O. Box 6248, Providence, RI 02940.

- * 17-23. **Singularitäten der Kontinuumsmechanik: Numerische und Konstruktive Methoden zu Ihrer Behandlung**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: W. L. Wendland, Stuttgart; J.R. Whiteman, West London.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 24-30. **Numerische Methoden der Approximationstheorie**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: D. Braess, Bochum; L.L. Schumaker, Nashville.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

December 1991

- * 1-7. **Statistik Stochastischer Prozesse**, Oberwolfach, F.R.G.

CHAIRMEN: H.R. Lerche, Freiburg; M.B. Woodroffe, Ann Arbor.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 8-14. **Stochastic Geometry, Geometric Statistics, Stereology**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: E. Bjorn Jensen, Aarhus; R.E. Miles, Queenbeyan W. Weil, Karlsruhe.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 15-21. **Quantenstochastik**, Oberwolfach, Federal Republic of Germany.

CHAIRMEN: L. Accardi, Rom; W. von Waldenfels, Heidelberg.

INFORMATION: Mathematisches Forschungsinstitut Oberwolfach, Geschäftsstelle: Albertstraße 24, D-7800 Freiburg im Breisgau.

- * 27-31. **Holiday Symposium on the Impact of Software Systems in Mathematical Research**, New Mexico State Univ., Las Cruces, NM.

PROGRAM: This year's symposium is focused on the impact of software systems in mathematical research. There will be a series of ten lectures, two each day, by J. Selfridge, of the Northern Illinois Univ. There will be additional sessions for contributed papers, research ideas, and discussion. Some support may be available for a limited number of participants.

INFORMATION: R.J. Wisner, Homotopy Theory Symposium, Dept. of Mathematical Sciences, New Mexico State Univ., Box 30001, Las Cruces, NM 88003-0001; 505-646-3901.

- * 1992. **IMACS Symposium on Symbolic Computation in Engineering Design**, IDN, Lille, France.

INFORMATION: P. Borne, B.P. 48, Institut Industriel du Nord, 59651 Villeneuve d'Ascq Cedex, France.

New AMS Publications

A. J. LOHWATER'S RUSSIAN-ENGLISH DICTIONARY OF THE MATHEMATICAL SCIENCES, Second Edition

Edited by Ralph P. Boas

Revised and expanded with the assistance of
Alana I. Thorpe

This long-awaited update of the popular Lohwater dictionary is currently the most complete and up-to-date resource for reading and translating mathematical literature written in Russian. Hundreds of new words have been added, and existing entries have been amplified, corrected, and brought up-to-date to reflect current mathematical usage (though some obsolete terms were retained for users who need to consult older literature). The grammar section has been rewritten, and an appendix contains complete paradigms of a large number of selected words. In addition, at the request of many users of the dictionary, stress markings on Russian words have been added.

Intended primarily for those whose first language is English, this dictionary will prove a useful tool for researchers, editors, and translators working with Russian mathematical literature.

1980 Mathematics Subject Classification: 00

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POSTERS BY ANATOLY FOMENKO

"I do not really think of myself as an artist. I am a mathematician. To me, my drawings are photographs of some strange and interesting mathematical world." —Anatoly Fomenko, in an interview with *Insight* magazine.

Anatoly Fomenko is a Soviet topologist with a special gift for expressing abstract mathematical concepts through art. Some of his work resembles that of M. C. Escher in its meticulous rendering of shapes and patterns, while other pieces seem to be more visceral expressions of mathematical ideas. Stimulating to the imagination and to the eye, his rich

and evocative work can be interpreted and appreciated in various ways—mathematical, aesthetic, or emotional.

In anticipation of the 1991 publication of a full volume of Fomenko's artwork, the AMS is now offering posters of four of his most striking pieces. Handsomely designed and suitable for framing, these posters would be a provocative conversation piece for home or office. They would also make excellent gifts. Photos of posters on page 756.

The cylinder of a continuous mapping. Given two topological spaces and a continuous mapping between them, one can "join" a point x to its image under the map, to obtain what is known as the cylinder of the mapping. This painting, rich in reds and maroon, is a poetic rendering of various mapping cylinders. A group of seagulls flies around a truncated cone, which represents a map that "enlarges" the domain space. In color.

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A two-dimensional sphere in three-dimensional space can be turned inside out. It is a remarkable topological fact that a two-dimensional sphere can be "turned inside out" by a smooth homotopy in the class of immersions. Fomenko depicts this amazing transformation in eight steps in this surrealistic illustration. In black and white.

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This series is devoted to the proceedings of conferences, symposia, and seminars. Collections of papers focusing on a certain subject will also be published. The Israel Mathematical Conference Proceedings are published by the Weizmann Science Press of Israel and are distributed worldwide, except in Israel, by the American Mathematical Society.

RING THEORY 1989 IN HONOR OF S. A. AMITSUR Louis Rowen, Editor

(Israel Mathematical Conference Proceedings, Volume 1)

This is the first volume in a new series, *Israel Mathematical Conference Proceedings*, published by the Weizmann Science Press of Israel. The volume contains the proceedings of The Ring Theory Symposium at Bar-Ilan University and The Division Algebra Workshop at Hebrew University, which were held in honor of S. A. Amitsur in late 1988 and early 1989. Virtually every major algebraist in Israel contributed to these events by inviting participants for a period coinciding with the conferences.

The papers in this volume range from presentations of current research to survey talks and expositions and represent contributions by some of the world's leading experts in algebra and ring theory.

Contents

Polynomial identity ring; Group algebras, crossed products and enveloping algebras; General ring theory; Division rings and central simple algebra.

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THE LEGACY OF JOHN VON NEUMANN James G. Glimm, John Impagliazzo, and Isadore Singer, Editors

(Proceedings of Symposia in Pure Mathematics, Volume 50)

The ideas of John von Neumann have had a profound influence on modern mathematics and science. One of the great thinkers of our century, von Neumann initiated major branches of mathematics—from operator algebras to game theory to scientific computing—and had a fundamental impact on such areas as self-adjoint operators, ergodic theory and the foundations of quantum mechanics, and numerical analysis and the design of the modern computer.

This volume contains the proceedings of an AMS Symposium in Pure Mathematics, held at Hofstra University, in May 1988. The symposium brought together some of the foremost researchers in the wide range of areas in which

von Neumann worked. These articles illustrate the sweep of von Neumann's ideas and thinking and document their influence on contemporary mathematics. In addition, some of those who knew von Neumann when he was alive have presented here personal reminiscences about him. This book is directed to those interested in operator theory, game theory, ergodic theory, and scientific computing, as well as to historians of mathematics and others having an interest in the contemporary history of the mathematical sciences. This book will give readers an appreciation for the workings of the mind of one of the mathematical giants of our time.

Contents

Marina v. N. Whitman, *John von Neumann: A personal view*; Peter D. Lax, *Remembering John von Neumann*; Françoise Ulam, *Nonmathematical reminiscences about Johnny von Neumann*; Israel Halperin, *The extraordinary inspiration of John von Neumann*; Nicholas A. Vonneuman, *The philosophical legacy of John von Neumann, in light of its inception and evolution in his formative years*; George W. Mackey, *Von Neumann and the early days of ergodic theory*; Donald S. Ornstein, *Von Neumann and ergodic theory*; Hillel Furstenberg, *Nonconventional ergodic averages*; Francis J. Murray, *The rings of operators papers*; Richard V. Kadison, *Operator algebras - An overview*; Alain Connes, *Introduction à la géométrie non-commutative*; Huzihiro Araki, *Some of the legacy of John von Neumann in physics: Theory of measurement, quantum logic, and von Neumann algebras in physics*; Arthur M. Jaffe, *Mathematics motivated by physics*; Irving E. Segal, *The mathematical implications of fundamental physical principles*; Herman H. Goldstine and John von Neumann, *On the principles of large scale computing machines*; James Glimm, *Scientific computing: Von Neumann's vision, today's realities, and the promise of the future*; Z-S. She, Eric Jackson, and S. A. Orszag, *Intermittency of turbulence*; E. Clementi, S. Chin, G. Corongiu, J. Given, G. C. Lie, M. Migliore, and P. Procacci, *Supercomputer simulations of the interaction of biomolecules in solution*; Jack D. Cowan, *Von Neumann and neural networks*; Elwyn R. Berlekamp, *Two-person, perfect-information games*; William Aspray, *The origins of John von Neumann's theory of automata*; Nicholas Pippenger, *Developments in the synthesis of reliable organisms from unreliable components.*

1980 *Mathematics Subject Classifications*: 28DXX, 46LXX, 65XX, 76XX, 81XX
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OPERATOR THEORY/OPERATOR ALGEBRAS AND APPLICATIONS William B. Arveson and Ronald G. Douglas, Editors

(Proceedings of Symposia in Pure Mathematics, Volume 51)

Operator theory has come of age during the last twenty years. The subject has developed in several directions using new and powerful methods that have led to the solution of basic problems previously thought to be inaccessible. In addition, operator theory has had fundamental connections with a range of other mathematical topics. For example, operator theory has made mutually enriching contacts with other areas of mathematics, such as algebraic topology and index theory, complex analysis, and probability theory.

The algebraic methods employed in operator theory are diverse and touch upon a broad area of mathematics. There have been direct applications of operator theory to systems theory and statistical mechanics. And significant problems and motivations have arisen from the subject's traditional underpinnings for partial differential equations.

This two-volume set contains the proceedings of an AMS Summer Institute on Operator Theory/Operator Algebras, held in July 1988 at the University of New Hampshire. The Institute sought to summarize progress and examine the common points of view that now run through the subject. With contributions from some of the top experts in the field, this publication illuminates a broad range of current research topics in operator theory.

Contents

PART 1

William Arveson, *The spectral C^* -algebra of an E_0 -semigroup*; **J. A. Ball, I. C. Gohberg, and L. Rodman**, *Two-sided Lagrange-Sylvester interpolation problems for rational matrix functions*; **A. Ben-Artzi and I. Gohberg**, *Nonstationary inertia theorems, dichotomy, and applications*; **Lewis Coburn**, *Toeplitz operators, quantum mechanics, and mean oscillation in the Bergman metric*; **John B. Conway**, *Towards a functional calculus for subnormal tuples: The minimal normal extension and approximation in several complex variables*; **H. O. Cordes**, *On the technique of comparison algebra for elliptic boundary problems on noncompact manifolds*; **Carl C. Cowen**, *Composition operators on Hilbert spaces of analytic functions: A status report*; **R. E. Curto, P. S. Muhly, and J. Xia**, *Random Toeplitz operators*; **Kenneth R. Davidson**, *Isomorphisms of nest algebras and their quotients*; **Ronald G. Douglas**, *Invariants for Hilbert modules*; **E. G. Effros and Z.-J. Ruan**, *Multivariable multipliers for groups and their operator algebras*; **J. William Helton**, *Beyond commutant lifting*; **Domingo A. Herrero**, *Similarity and approximation of operators*; **Nigel D. Higson**, *A primer on KK -theory*; **Alan Hopenwasser**, *Complete distributivity*; **Jerry Kaminker**, *Operator algebraic invariants for elliptic operators*; **Abel Klein**, *The supersymmetric replica trick and smoothness of the density of states for random Schrödinger operators*; **David R. Larson**, *Some recent progress in nest algebras*; **Vern I. Paulsen**, *Rigidity theorems in spaces of analytic functions*; **Vladimir V. Peller**, *Hankel operators and multivariate stationary processes*; **Joel Pincus**, *The principal index*; **Stephen C. Power**, *Refinement theory for nonselfadjoint operator algebras*; **Robert T. Powers**, *Some remarks on the index theory for semigroups of endomorphisms of $B(H)$* ; **Marc A. Rieffel**, *Deformation quantization and operator algebras*; **Richard Rochberg**, *Toeplitz and Hankel operators, wavelets, NWO sequences, and almost diagonalization of operators*; **Jonathan Rosenberg**, *K and KK : Topology and operator algebras*; **Norberto Salinas**, *Applications of C^* -algebras and operator theory to proper holomorphic mappings*; **Donald E. Sarason**, *Function theory and de Branges's spaces*; **Irving Segal**, *Algebraic quantization and stability*; **Baruch Solel**, *Analytic operator algebras*; **U. Haagerup and E. Størmer**, *Automorphisms which preserve unitary equivalence classes of normal states*; **Masamichi Takesaki**, *Cocycle conjugacy of group actions on factors*; **Michael E. Taylor**, *Pseudodifferential operators and K -homology*; **Harald Upmeyer**, *Toeplitz operators and index theory in several complex variables*; **Harold Widom**, *Szegő expansions for operators with smooth or nonsmooth symbol*; **Daoning Xia**, *Analytic theory of subnormal n -tuple of operators*;

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1980 Mathematics Subject Classifications: 46L, 47A, 47B, 58G
ISBN 0-8218-1486-9, LC 90-33771, ISSN 0082-0717
Part 1-640 pages, Part 2-385 pages (hardcover), July 1990
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AN INTRODUCTION TO CR STRUCTURES Howard Jacobowitz

(Mathematical Surveys and Monographs, Volume 32)

The geometry and analysis of CR manifolds is the subject of this expository work, which presents all the basic results on this topic, including results from the "folklore" of the subject.

The book contains a careful exposition of seminal papers by Cartan and by Chern and Moser, and also includes chapters on the geometry of chains and circles and the existence of nonrealizable CR structures. With its detailed treatment of foundational papers, the book is especially useful in that it gathers in one volume many results that were scattered throughout the literature.

Directed at mathematicians and physicists seeking to understand CR structures, this self-contained exposition is also suitable as a text for a graduate course for students interested in several complex variables, differential geometry, or partial differential equations. A particular strength is an extensive chapter that prepares the reader for Cartan's approach to differential geometry. The book assumes only the usual first-year graduate courses as background.

Contents

CR Structures; Some automorphism groups; Formal theory of the normal form; Geometric theory of the normal form; Background for Cartan's work; Cartan's construction; Geometric consequences; Chains; Chains and circles in complex projective geometry; Nonsolvability of the Lewy Operator.

1980 *Mathematics Subject Classifications*: 32F25; 32-02, 53-02
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SPECTRAL THEORY AND ANALYTIC GEOMETRY OVER NON-ARCHIMEDEAN FIELDS

Vladimir G. Berkovich

(Mathematical Surveys and Monographs, Volume 33)

The purpose of this book is to introduce a new notion of analytic space over a non-Archimedean field. Despite the total disconnectedness of the ground field, these analytic spaces have the usual topological properties of a complex analytic space, such as local compactness and local arcwise connectedness. This makes it possible to apply the usual notions of homotopy and singular homology. The book includes a homotopic characterization of the analytic spaces associated with certain classes of algebraic varieties and an interpretation of Bruhat-Tits buildings in terms of these analytic spaces. The author also studies the connection with the earlier notion of a rigid analytic space. Geometrical considerations are used to obtain some applications, and the analytic spaces are used to construct the foundations of a non-Archimedean spectral theory of bounded linear operators. This book requires a background at the level of basic graduate courses in algebra and topology, as well as some familiarity with algebraic geometry. It would be of interest to research mathematicians and graduate students working in algebraic geometry, number theory, and p -adic analysis.

Contents

The spectrum of a commutative Banach ring; Affinoid spaces; Analytic spaces; Analytic curves; Analytic groups and buildings; The homotopy type of certain analytic spaces; Spectral theory; Perturbation theory; The dimension of a Banach algebra.

1980 *Mathematics Subject Classifications*: 12J25, 32K10, 14G20, 20G25, 46P05, 46J99
ISBN 0-8218-1534-2, LC 90-830, ISSN 0076-5376
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NONLINEAR WAVE EQUATIONS, FORMATION OF SINGULARITIES

Fritz John

(University Lecture Series, Volume 2)

This is the second volume in the new University Lecture Series, designed to make more widely available some of the outstanding lectures presented in various institutions around the country. Each year at Lehigh University, a distinguished mathematical scientist presents the Pitcher Lectures in the Mathematical Sciences. This volume contains the Pitcher lectures presented by Fritz John in April 1989.

The lectures deal with existence in the large of solutions of initial value problems for nonlinear hyperbolic partial differential equations. As is typical with nonlinear problems, there are many results and few general conclusions in this extensive subject, so the author restricts himself to a small portion of the field, in which it is possible to discern some general patterns. Presenting an exposition of recent research in this area, the author examines the way in which solutions can, even with small and very smooth initial data, "blow up" after a finite time. For various types of quasi-linear equations, this time depends strongly on the number of dimensions and the "size" of the data. Of particular interest is the formation of singularities for nonlinear wave equations in three space dimensions.

Contents

Equations in one space variable; Blow-up in higher dimensions; Longtime existence for solutions of nonlinear wave equations with small initial data; Appendix I. Uniqueness for nonlinear wave equations; Appendix II. Klainerman's inequality.

1980 *Mathematics Subject Classifications*: 35L67, 35L70; 73G05
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WORLD DIRECTORY OF MATHEMATICIANS 1990

This is the ninth edition of the *World Directory of Mathematicians*, which incorporates corrections and updates to the 1986 edition. Published by the International Mathematical Union, this valuable reference book contains the names and addresses of about 40,000 mathematicians from 83 countries. Listings for the directory are based on information supplied by National Committees for Mathematics (or corresponding organizations). Listings from the 1986 edition were retained if no updated information was supplied.

Libraries and individuals alike will find this a useful directory to have on hand.

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The following videotapes are now available through the AMS.

$$ax^2 + hxy + cy^2 = n$$

John H. Conway

Focusing on a pictorial approach to the theory of integral quadratic forms, John H. Conway combines an impressive command of the theory with deep intuitive insight to produce an illuminating and engaging videotaped lecture. The quadratic forms of the type in the title of this lecture lead to a beautiful picture in the hyperbolic plane—a picture that not only allows for understanding of the deeper properties of these forms but also leads to an algorithm for their solution. Taking viewers on a trip down "the river," with a forest of positive integers on one side, and negative integers on the other, Conway shows how this simple representation elucidates certain properties of the forms. His approach also leads to a discussion of an alternative, pictorial representation of the real numbers that reveals their Diophantine structure, leading naturally to the concept of the continued fraction representation. This lecture is fascinating not only in its subject matter but also in revealing the way this master mathematician wends his intuitive way through the topic as he leaves the technicalities behind. The videotape would be appropriate for advanced undergraduates with background in number theory.

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CRYSTALS, IN EQUILIBRIUM AND OTHERWISE

Jean E. Taylor

The opening shots on this videotape, showing computer-generated pictures of soap bubbles and crystals, beautifully illustrate the fascination of this topic. Soap films are the physical system that gave rise to the mathematical subject of minimal surfaces; their surface energy is proportional to the surface area. Like fluid interfaces, interfaces involving crystals also have surface energies, but the surface energy per unit surface area depends on the normal directions of the interfaces. Those portions of crystal surfaces or interfaces which minimize surface energy have given rise to the study of crystalline minimal surfaces. With their faceted structure, these surfaces share the beauty of both crystals and soap films. Taylor communicates her great enthusiasm for the subject as she presents a variety of results and pictures. Audiences having a background at the level of an advanced

undergraduate in mathematics will enjoy this presentation, and it is likely to be of interest to physicists and engineers.

1980 *Mathematics Subject Classifications*: 49, 51
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THE TRANSITION TO CHAOS: THE ORBIT DIAGRAM AND THE MANDELBROT SET

Robert L. Devaney

A Science Television Production

In this videotaped lecture, Devaney explores and explains two of the most fascinating images in the study of dynamical systems: the orbit (or bifurcation) diagram, and the Mandelbrot set. Because both of these images result from iterations of quadratic functions, the level of mathematical sophistication required to understand the lecture is minimal. The main goal of the lecture is to describe the relationship between these two images, how they are generated, and what they mean mathematically. Devaney also describes several important related concepts in dynamical systems theory, including period doubling bifurcations, Feigenbaum's number, Sarkovskii's theorem, and the role of critical orbits.

1980 *Mathematics Subject Classification*: 58
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lectures would be suitable for researchers, graduate students, or advanced undergraduates.

MATHEMATICAL PROBLEMS OF LIQUID CRYSTALS

Haim Brezis

Liquid crystals are now an everyday phenomenon, with the advent of liquid crystal displays in clocks, watches, calculators, computers, and other devices. Such materials are unusual because they have an orientational order, but do not have the strict configurational order of solids. This videotaped lecture provides an in-depth view of some of the mathematical aspects of liquid crystals. Brezis discusses some current results on the deformation energy of liquid crystals. These results not only provide an excellent example of how physical phenomenon can provide new mathematical problems, but also shows the way in which mathematical analysis can point physicists in the direction of new understanding. In addition, the fascination of this topic goes well beyond the connection to liquid crystals, forging an unusual combination of techniques from various fields such as nonlinear partial differential equations, functional analysis, differential geometry, geometric measure theory, topology, numerical analysis, and graph theory. Lecturing with clarity, insight, and thoroughness, Brezis leads the audience on a journey into this absorbing topic at the frontier of research. In addition to researchers interested in this area, graduate students or advanced undergraduates should find this lecture accessible.

1980 *Mathematics Subject Classifications*: 35J, 58C, 58E
ISBN 0-8218-8030-6
NTSC format on 1/2" VHS videotape; approx. 90 minutes, 1990
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APPLICATIONS OF PDE METHODS BY GROMOV, FLOER, AND OTHERS TO SYMPLECTIC GEOMETRY

Dusa McDuff

The past few years have seen several exciting developments in the field of symplectic geometry, and researchers in this area have begun to make progress in solving many important and hitherto inaccessible problems. The new techniques making this possible have come both from the calculus of variations and from the theory of elliptic partial differential operators. With impressive breadth of knowledge and clarity of exposition, McDuff examines some of these new developments, including Gromov's results using elliptic methods, and how Floer applied these elliptic techniques to develop a new approach to Morse theory. This latter result has important applications in the theory of 3- and 4-manifolds, as well as in symplectic geometry. In addition to researchers interested in this area, graduate students or advanced undergraduates should find this lecture accessible.

1980 *Mathematics Subject Classifications*: 53C15, 58G05
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HARMONIC ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS

Mario Milman and Tomas Schonbek, Editors
(Contemporary Mathematics, Volume 107)

This volume contains the proceedings of an AMS Special Session on the Mathematics of Nonlinear Science, held in Phoenix in January 1989. This area of research encompasses a large and rapidly growing set of ideas concerning the relationship of mathematics to science, in which the fundamental laws of nature are extended beyond common sense into new areas where the dual aspects of order and chaos abound.

These papers, generally analytic in nature, deal primarily with mathematical aspects of physical science and non-chaotic phenomenon. Important new areas are discussed, such as instability, global extensions of KAM theory, new ideas concerning integrable systems, bifurcation and its applications in fluids, and various aspects of gauge theory. Altogether, the topics explored here represent an excellent survey of some of the new research in the mathematics of nonlinear science.

Contents

B. Barcelo, L. Escauriaza, and E. Fabes, *Gradient estimates at the boundary for solutions to nondivergence elliptic equations*;
L. A. Caffarelli, *Interior regularity of solutions to Monge-Ampère equations*; M. Cotlar and C. Sadosky, *The Helson-Szegő theorem in L^p of the bidimensional torus*; B. E. J. Dahlberg and G. Verchota, *Galerkin methods for the boundary integral equations of elliptic equations in nonsmooth domains*; R. Fefferman, *Some applications of Hardy spaces and BMO in harmonic analysis and partial differential equations*; B. Jawerth, C. Perez, and G. Welland, *The positive cone in Triebel-Lizorkin spaces and the relation among potential and maximal operators*; R. Johnson, *Changes of variable and A_p weights*; C. E. Kenig, *Progress on two problems posed by Riviere*; A. C. Lazer and P. J. McKenna, *Fredholm theory for periodic solutions of some semilinear P.D.E.s with homogeneous nonlinearities*; W. A. Strauss, *Stability of solitary waves*.

1980 *Mathematics Subject Classifications*: 35-06, 42-06
ISBN 0-8218-5113-6, LC 90-34635, ISSN 0271-4132
129 pages (softcover), July 1990
Individual member \$23, List price \$38,
Institutional member \$30
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MATHEMATICS OF NONLINEAR SCIENCE

Melvyn S. Berger, Editor

(Contemporary Mathematics, Volume 108)

This book brings together ten papers presented at the Conference on Harmonic Analysis and Partial Differential Equations, held in April 1987 at Florida Atlantic University. The papers illuminate the relationship between harmonic analysis and partial differential equations and present results

of some of the foremost experts in these areas. Among the topics covered are: application of fully nonlinear, uniformly elliptic equations to the Monge Ampère equation; estimates for Green functions for the purpose of studying Dirichlet problems for operators in non-divergence form; an extension of classical potential theory to the case of nonsmooth domains; the relation between Riesz potentials and maximal fractional operators due to Muckenhoupt and Wheeden; and the Lax-Phillips scattering theory applied to the double Hilbert transform. Directed at research mathematicians and graduate students, the papers require knowledge of the classical tools of analysis, such as measure theory, Sobolev spaces, and potential theory.

Contents

Roger K. Alexander, *Multiple steady states in tubular chemical reactors*; M. S. Berger, *Two new approaches to large amplitude quasi-periodic motions of certain nonlinear Hamiltonian systems*; Y. Y. Chen, *Vortices for the Ginzburg-Landau equations—the nonsymmetric case in bounded domain*; Andrew Szeri and Philip Holmes, *Nonlinear stability and bifurcation in Hamiltonian systems with symmetry*; Eli Isaacson and Blake Temple, *Nonlinear resonance in inhomogeneous systems of conservation laws*; George H. Knightly and D. Sather, *Bifurcation and stability in rotating, plane Couette-Poiseuille flow*; Kenneth R. Meyer and Dieter S. Schmidt, *Bifurcations of central configurations in the N-body problem*; M. S. Berger and J. Nee, *Leapfrogging of vortex filaments in an ideal fluid*; J. W. Neuberger, *Calculation of sharp shocks using Sobolev gradients*; John Palmer and Craig A. Tracy, *Monodromy preserving deformation of the Dirac operator acting on the hyperbolic plane*; M. S. Berger and M. Schechter, *Bifurcation from equilibria for certain infinite-dimensional dynamical systems*; Victor Shubov, *On dynamics of discrete and continuous σ -models (chiral fields) with values in Riemannian manifolds*; Srdjan Stojanovic, *Direct study for some nonlinear elliptic control problems*.

1980 Mathematics Subject Classifications: 70-XX, 70DXX, 70FXX, 70HXX, 70KXX; 34BXX, 35-XX, 35BXX, 49-XX, 49FXX, 58-XX, 58BXX
ISBN 0-8218-5114-4, LC 90-574, ISSN 0271-4132
154 pages (softcover), July 1990
Individual member \$19, List price \$32,
Institutional member \$26
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A MULTIPLE DISJUNCTION LEMMA FOR SMOOTH CONCORDANCE EMBEDDINGS

Thomas G. Goodwillie

(Memoirs of the AMS, Number 431)

Requiring background in basic differential topology, this book is aimed at researchers interested in the homotopy type of spaces of smooth embeddings and spaces of diffeomorphisms. The author provides a proof of a useful connectivity estimate in the theory of concordances (or pseudo-isotopies), generalizing Morlet's result from triads to n -ads. The method of proof is a differentiable general position technique analogous to piecewise-linear "sunny collapsing."

Contents

Introduction: Spaces of concordances; Known results; The multiple disjunction lemma; Sketch of the proof; Preliminaries: Definitions, etc.; $(a+1)$ -ads and connectivity; Sunny collapsing; Multijets and general position; Approximation by polynomials; The collection Z of multiset sets; Invariant algebraic sets of complex multijets; Operations

on sets of multijets; Z ; Singular sets for fibered concordances; Proof of Theorem D: One last sunny collapse.

1980 Mathematics Subject Classification: 57
ISBN 0-8218-2493-7, LC 90-31826, ISSN 0065-9266
317 pages (softcover), July 1990
Individual member \$22, List price \$36,
Institutional member \$29
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THE MAXIMAL FACTORIZATIONS OF THE FINITE SIMPLE GROUPS AND THEIR AUTOMORPHISM GROUPS

Martin W. Liebeck, Cheryl E. Praeger, and Jan Saxl

(Memoirs of the AMS, Number 432)

Factorizations of finite groups as a product of two proper subgroups arise naturally in several areas of group theory, geometry, and applications. In this book, the authors determine all factorizations of the finite simple groups and their automorphism groups as a product of two maximal subgroups. The proof involves detailed study of the geometry of simple groups, and there is a substantial introductory section presenting this material. One of the major unsolved problems in the theory of finite groups is the classification of the maximal subgroups of the finite simple groups and their automorphism groups. As an application of their main results, the authors present an effective classification of the maximal subgroups of one such class, the finite alternating and symmetric groups. Requiring a basic knowledge of group theory, the book is directed at research mathematicians and graduate students.

Contents

Classical groups of large dimension: factorizations as a product of two geometric subgroups; Classical groups of large dimension: factorizations in which one of the factors is non-geometric; Classical groups of small dimension; Factorizations of sporadic groups; Factorizations of alternating groups; Factorizations of exceptional groups of Lie type; On maximal subgroups of symmetric and alternating groups; Lower bounds for dimensions of representations of sporadic groups; Uniqueness of certain representations of Suz and Co_1 ; Orbit decomposition of $B_4(q)$ on a spin module.

1980 Mathematics Subject Classifications: 20D40, 20B35, 20D06, 20D08, 20E40
ISBN 0-8218-2494-5, LC 90-31827, ISSN 0065-9266
151 pages (softcover), July 1990
Individual member \$22, List price \$36,
Institutional member \$29
To order, please specify MEMO/432N

GEOMETRIC FUNCTION THEORY IN SEVERAL COMPLEX VARIABLES

Junjiro Noguchi and Takushiro Ochiai

(Translations of Mathematical Monographs, Volume 80)

This is an expanded English-language version of a book by the same authors that originally appeared in the Japanese. The book serves two purposes. The first is to provide a

self-contained and coherent account of recent developments in geometric function theory in several complex variables, aimed at those who have already mastered the basics of complex function theory and the elementary theory of differential and complex manifolds. The second goal is to present, in a self-contained way, fundamental descriptions of the theory of positive currents, plurisubharmonic functions, and meromorphic mappings, which are today indispensable in the analytic and geometric theories of complex functions of several variables. The book should prove useful for researchers and graduate students alike.

Contents

Hyperbolic manifolds; Measure hyperbolic manifolds; Positive currents and plurisubharmonic functions; Meromorphic mappings; Nevanlinna theory; Value distribution of holomorphic curves.

1980 *Mathematics Subject Classifications*: 32H30; 32F05

ISBN 0-8218-4533-0, LC 90-546, ISSN 0065-9282

296 pages (hardcover), July 1990

Individual member \$47, List price \$78,

Institutional member \$62

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MATHEMATICAL PROBLEMS OF TOMOGRAPHY

I. M. Gelfand and S. G. Gindikin, Editors

(Translations of Mathematical Monographs, Volume 81)

As early as 1917, Radon derived an explicit formula for the reconstruction of a function on the plane, given its integrals over all lines. In the late 1960s, the first applications of the Radon formula appeared, in radio astronomy and then in electron micrography. The use of the Radon formula for constructing tomograms, made possible by the advent of the computer, saw its first use in clinical medicine in 1970 and earned its developers the Nobel Prize in medicine.

Today, practical application of the Radon transform, especially in medical tomography, has continued to capture the attention of mathematicians, partly because of the range of new applications that have been found. But the most fascinating aspect for mathematicians may be the opportunity to apply deep mathematics to tackle new problems arising from real-world applications.

The papers in this volume cover various problems arising from and related to computerized tomography. The main idea unifying the papers is that the methods used satisfy strong requirements imposed by practical applications of computerized tomography, such as reconstruction of nonsmooth functions, pointwise convergence, and discretization in computational algorithms. The papers draw upon a broad range of mathematical areas, including integral geometry, the theory of several complex variables, the theory of distributions, and integral transformations. In addition, applications to reconstruction of biological objects and mathematical economics are given.

Contents

I. M. Gelfand and S. G. Gindikin, *Introduction. Integral geometry and tomography*; **D. A. Popov**, *On convergence of a class of algorithms for the inversion of the numerical Radon transform*; **A. B. Goncharov**, *Three-dimensional reconstruction of arbitrarily arranged identical*

particles given their projections; **M. S. Gelfand and A. B. Goncharov**, *Spatial rotational alignment of identical particles given their projections*; **V. P. Palamodov**, *Some singular problems in tomography*; **N. D. Vvedenskaya and S. G. Gindikin**, *Discrete Radon transform and image reconstruction*; **G. M. Henklin and A. A. Shananin**, *Bernstein theorems and the Radon transform. Application to the theory of production functions*; **V. M. Buchstaber and V. K. Maslov**, *Mathematical models and algorithms of tomographic synthesis of wave fields and inhomogeneous media.*

1980 *Mathematics Subject Classifications*: 44A05, 44A15; 46F12, 44-04, 90A15, 32A25

ISBN 0-8218-4534-9, LC 90-845, ISSN 0065-9282

267 pages (hardcover), July 1990

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LINEAR DIFFERENTIAL EQUATIONS IN THE COMPLEX DOMAIN: PROBLEMS OF ANALYTIC CONTINUATION

Yasutaka Sibuya

(Translations of Mathematical Monographs, Volume 82)

Research in differential equations is usually oriented toward explicit results and motivated by applications. Many clever methods have been discovered in this way, but, when problems of more fundamental difficulty arise, researchers must find something intrinsic in the mathematics itself in order to make progress. As research in topology, algebraic geometry, and functions of several complex variables have advanced, many methods useful in such fields were introduced into the study of differential equations.

The main part of this book is a translation of a 1976 book originally written in Japanese. The book, focusing attention on intrinsic aspects of the subject, explores some problems of linear ordinary differential equations in complex domains. Examples of the problems discussed include the Riemann problem on the Riemann sphere, a characterization of regular singularities, and a classification of meromorphic differential equations. Since the original book was published, many new ideas have developed, such as applications of D-modules, Gevrey asymptotics, cohomological methods, k -summability, and studies of differential equations containing parameters. Five appendices, added in the present edition, briefly cover these new ideas. In addition, more than 100 references have been added.

This book will introduce readers to the essential facts concerning the structure of solutions of linear differential equations in the complex domain, as well as illuminate the intrinsic meaning of older results by means of more modern ideas. A useful reference for research mathematicians on various fundamental results, this book would also be suitable as a textbook in a graduate course or seminar.

Contents

Structures of analytic continuation; Existence theorem of Grauert; A theorem of G. D. Birkhoff; The Riemann problem; Linear differential equations on a sectorial domain; The Stokes phenomena; Appendix 1. The Hukuhara Turrittin Theorem in terms of D_X -modules; Appendix 2. Gevrey asymptotics; Appendix 3. Cohomological methods; Appendix 4.

k-Summability; Appendix 5. Differential equations containing parameters.

1980 Mathematics Subject Classifications: 34A20, 32D20, 32E10, 34E05, 30E15

ISBN 0-8218-4535-7, LC 90-825, ISSN 0065-9282

267 pages (hardcover), JULY 1990

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SOCIÉTÉ MATHÉMATIQUE DE FRANCE, ASTÉRISQUE

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REPRÉSENTATIONS LINÉAIRES DES GROUPE FINIS

(Astérisque, Number 181-182)

This volume brings together fifteen research papers presented at the International Conference on Linear Representations of Finite Groups, held in Luminy in May 1988. One of the major themes of the volume is the notion of block. Among the topics discussed are studies of Alperin's conjecture, the isomorphism problem for group algebras, and blocks of classical groups. Local methods, source algebras, Auslander-Reiten theory, Morita equivalence, isometries, permutation modules, derived categories, cohomological methods, and Mackey functors are some of the key concepts touched on here. Apart from the focus on the theme of blocks, readers will also find other topics represented here, such as representations of finite groups of Lie type, linear codes, and character theory.

Content

Christine Bessenrodt, *Some new block invariants coming from cohomology*; **Robert Boltje**, *A canonical Brauer induction formula*; **Michel Broué**, *Isométries parfaites, types de blocs, catégories dérivées*; **Marc Cabanes**, *A criterion for complete reducibility and some applications*; **François Digne and Jean Michel**, *On Lusztig's parametrization of characters of finite groups of Lie type*; **Michel Enguehard**, *Isométries parfaites entre blocs de groupes symétriques*; **Karin Erdmann**, *On the local structure of tame blocks*; **Odile Garotta**, *On Auslander-Reiten systems*; **Reinhard Knörr and Wolfgang Willems**, *The automorphism groups of generalized Reed-Muller codes*; **Burkhard Külshammer**, *Morita equivalent blocks in Clifford theory of finite groups*; **Udo Leisering**, *On the p-part of character degrees of solvable groups*; **Lluís Puig**, *Algèbres de source de certains blocs des groupes de Chevalley*; **Geoffrey R. Robinson and Reiner Staszewski**, *More on Alperin's conjecture*; **Leonard L. Scott**, *Defect groups and the isomorphism problem*; **Jacques Thévenaz and Peter Webb**, *Mackey functor versions of a conjecture of Alperin*.

1980 Mathematics Subject Classification: 20
ISSN 0303-1179

274 pages (softcover), 1990

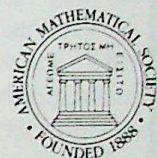
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Recent Developments in Geometry

S.-Y. Cheng, H. Choi, and Robert E. Greene, Editors
(Contemporary Mathematics, Volume 101)

This volume is the outgrowth of a Special Session on Geometry, held at the November 1987 meeting of the AMS at the University of California at Los Angeles. The unusually well-attended session attracted more than sixty participants and featured over forty addresses by some of the day's outstanding geometers. By common consent, it was decided that the papers to be collected in the present volume should be surveys of relatively broad areas of geometry, rather than detailed presentations of new research results. A comprehensive survey of the field is beyond the scope of a volume such as this. Nonetheless, the editors have sought to provide all geometers, whatever their specialties, with some insight into recent developments in a variety of topics in this active area of research.



1980 Mathematics Subject Classifications: 53C20, 53C42, 53C55, 53A10, 58E20, 58G25, 32B30, 32H20
ISBN 0-8218-5107-1, LC 89-18039

ISSN 0271-4132

352 pages (softcover), December 1989

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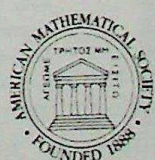
THEORY OF FUNCTIONS AND RELATED QUESTIONS OF ANALYSIS

L. D. Kudryavtsev, Editor

(Proceedings of the Steklov Institute, Volume 180)

This volume contains the proceedings of the All-Union Conference on the Theory of Functions and Related Questions of Analysis, held in Dnepropetrovsk, U.S.S.R., in the summer of 1985. The conference was held in honor of the 80th birthday of Sergei Mikhailovich Nikol'skii.

The collection contains a survey of the work of Nikol'skii as well as papers on the theory of approximation of functions, the metric theory of functions, the theory of spaces of differentiable functions of several variables, and applications of these ideas.



1980 Mathematics Subject Classifications: 01, 11, 26, 28, 30, 31, 34, 35, 39, 40, 41, 42, 44, 45, 46, 47, 53, 54, 65 and others
ISBN 0-8218-3218-3, LC 89-18114, ISSN 0081-5438

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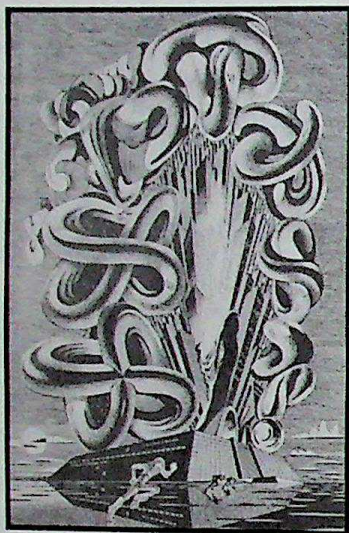
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POSTERS BY ANATOLY FOMENKO

"I do not really think of myself as an artist. I am a mathematician. To me, my drawings are photographs of some strange and interesting mathematical world." ---Anatoly Fomenko, in an interview with Insight magazine.

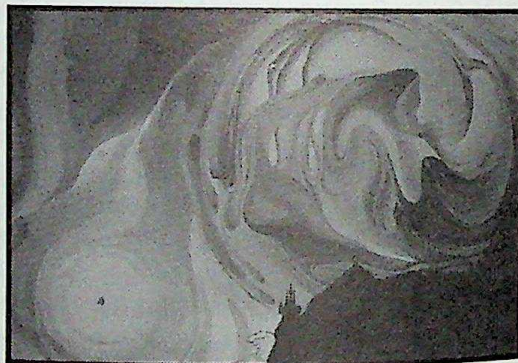
Anatoly Fomenko is a Soviet topologist with a special gift for expressing abstract mathematical concepts through art. Some of his work resembles that of M.C. Escher in its meticulous rendering of shapes and patterns, while other pieces seem to be more visceral expressions of mathematical ideas. Stimulating to the imagination and to the eye, his rich and evocative work can be interpreted and appreciated in various ways---mathematical, aesthetic, or emotional.

In anticipation of the 1991 publication of a full volume of Fomenko's artwork, the AMS is now offering posters of four of his most striking pieces.

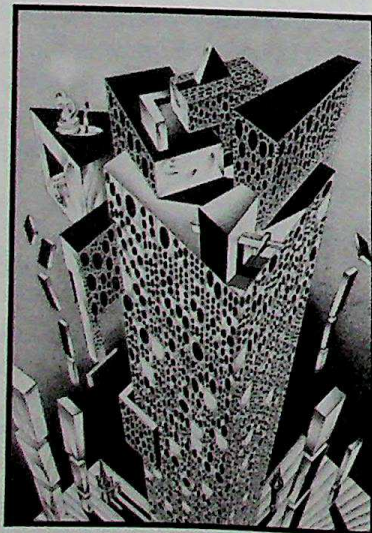


The cylinder of a continuous mapping. (Photo not given) Given two topological spaces and a continuous mapping between them, one can "join" a point x to its image under the map, to obtain what is known as the cylinder of the mapping. This painting, rich in reds and maroon, is a poetic rendering of various mapping cylinders. A group of seagulls flies around a truncated cone, which represents a map that "enlarges" the domain space. In color. **Price \$15. Code FOMPOS/1NA**

A two-dimensional sphere in three-dimensional space can be turned inside out. It is a remarkable topological fact that a two-dimensional sphere can be "turned inside out" by a smooth homotopy in the class of immersions. Fomenko depicts this amazing transformation in eight steps in this surrealistic illustration. In black and white. **Price \$12. Code FOMPOS/2NA**



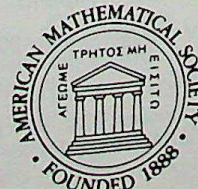
Homotopy groups of spheres. One important unsolved problem is the computation of the homotopy groups of spheres, which are formed by the classes of homotopic mappings from one sphere to another. This picture shows how a large sphere crumples, folds, and layers itself as it maps homotopically onto a smaller sphere. It can also be seen as a haunting image of a castle on the edge of a cliff, against a swirling yellow sky. In color. **Price \$15. Code FOMPOS/4NA**



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Handsomely designed and suitable for framing, these posters would be a provocative conversation piece for home or office. They would also make excellent gifts.

Miscellaneous

Personals

Neal R. Amundson, Cullen Professor of Chemical Engineering and professor of mathematics, University of Houston, has been named the recipient of the National Academy of Engineering's Founders Award in recognition of his "contributions to the advancement of the discipline of chemical engineering, blending mathematical analysis and practical applications, and for inspiring generations of students to attain leadership positions in academia and industry."

Thomas Branson, of the University of Iowa, has been promoted to full professor at that institution.

Do Ngoc Diep, of the Institute of Mathematics, Hanoi, has been appointed professor and senior researcher of the chair for "Geometry, Topology and their applications in physics and mechanics" at that institution.

Neal D. Hulkower, of The Mitre Corporation, has been honored by having an asteroid named after him. Designated (4285) Hulkower, the asteroid is one of the myriad of small planets orbiting the sun between Mars and Jupiter and ranging in size from a fraction of a mile to about 620 miles in diameter. The asteroid was discovered on July 11, 1988 at Mt. Palomar Observatory by Eleanor F. Helin, a research colleague in California. The citation from the International Astronomical Union states that the asteroid has been "named in honor of Neal D. Hulkower, mathematician, scientist, and good friend of the discoverer with a special inter-

est in celestial mechanics".

Vaughan F.R. Jones, of the University of California, Berkeley, was elected to Fellowship of the Royal Society on March 15, 1990.

Lee Lorch, Professor Emeritus of York University, was awarded an honorary degree by the City University of New York on May 25 at the commencement exercises of the City College of New York. The degree was conferred in recognition of his "...distinguished contributions in the field of mathematics and for his lifelong dedication to human rights, justice, and equality...".

Ved P. Madan, of Red Deer College, has been appointed professor of mathematics at Indiana University.

Gene W. Medlin is retiring from Stetson University and has been named Professor Emeritus of that institution.

Bertram Mond, of La Trobe University, has been appointed Dean of the School of Mathematical and Information Sciences at that institution.

Deborah A. Nolan, of the University of California, Berkeley, has been honored with the Prytanean Faculty Award recognizing an outstanding young woman faculty member at that institution.

Marjorie Lee Senechal, of Smith College, has been named the Louise Wolff Kahn Professor of Mathematics at that institution.

Monty J. Strauss, of Texas Tech University, has been appointed Associate Dean for Admissions and Information Systems in the Graduate

School at that institution.

René Thom, of the Institute des Hautes Etudes Sciences, was elected an honorary member of the London Mathematical Society.

Deaths

Robert A. Bonic, of Boston, Massachusetts, died on May 29, 1990, at the age of 57. He was a member of the Society for 30 years.

M.S. Brodskii, of Odessa, U.S.S.R., died on December 2, 1989. He was a member of the Society for 17 years.

A.S. Galbraity, of Lakewood, New Jersey, died on January 1, 1990, at the age of 85. He was a member of the Society for 57 years.

Edward K. Haviland, of Baltimore, Maryland, died on July 17, 1989, at the age of 87. He was a member of the Society for 60 years.

Albert F. Herbst, of La Verne, California, died on April 29, 1990, at the age of 61. He was a member of the Society for 33 years.

F. Jessie MacWilliams, of Bernardsville, New York, died on May 27, 1990, at the age of 73. She was a member of the Society for 27 years.

S. Thomas Parker, of Manhattan, Kansas, died on March 14, 1990, at the age of 76. He was a member of the Society for 51 years.

Rafael Sanchez-Diaz, of Hollywood, Florida, died on January 19, 1990, at the age of 88. He was a member of the Society for 63 years.

James E. Skeath, of Swarthmore College, died on April 29, 1990, at the age of 53. He was a member of the Society for 28 years.

Visiting Mathematicians

(Supplementary List)

The list of visiting mathematicians includes both foreign mathematicians visiting in the United States and Canada, and Americans visiting abroad. Note that there are two separate lists.

American Mathematicians Visiting Abroad

<u>Name and Home Country</u>	<u>Host Institution</u>	<u>Field of Special Interest</u>	<u>Period of Visit</u>
Mislove, Michael (U.S.A.)	Oxford University	Domain Theory and Denotational Semantics	1/91 - 7/91
Park, Dong Ho (U.S.A.)	Pohang Institute, Korea	Statistics	8/90 - 5/91
Schulz, Friedmar (U.S.A.)	Australian National University	Partial Differential Equations	8/90 - 12/90

Visiting Foreign Mathematicians

Beltrametti, Mauro (Italy)	University of Notre Dame	Algebraic Geometry	8/90 - 5/91
Brodzki, Jacek (Poland)	University of Texas, Austin	Physics	9/90 - 5/91
Busque, Claudi (Spain)	University of Texas, Austin	Algebra	9/90 - 5/91
Chen, Yu (China)	University of Notre Dame	Algebra	8/90 - 1/91
Cheng, Chi-Lun (China)	University of Texas, Austin	Mathematics and Statistics	9/90 - 5/91
Colliot-Thelene, J.-L. (France)	Harvard University	Number Theory, Algebraic Geometry	2/91 - 6/91
Domanski, Wlodzimierz (Poland)	University of Nebraska-Lincoln	Applied Mathematics, PDE's	8/90 - 5/91
Drinfeld, Vladimir (U.S.S.R.)	Harvard University	Algebraic Geometry, Quantum Groups	2/91 - 6/91
Falcolini, Corrado (Italy)	University of Texas, Austin	Perturbation Theory	9/90 - 5/91
Herwig, Bernard (West Germany)	University of Notre Dame	Logic	8/90 - 5/91
Its, Alexander (U.S.S.R.)	Clarkson University	Integrable Systems	8/90 - 8/91
Kozniowski, Tadeusz (Poland)	University of Poland	Topology	8/90 - 5/91
Lomonosov, Viktor (U.S.S.R.)	Kent State University	Invariant Subspaces	3/90 - 6/91
Loos, Ottmar (Austria)	University of Ottawa	Jordan Pairs	9/90 - 11/90
Margulis, Gregorii (U.S.S.R.)	Harvard University	Ergodic Theory, Lie Group Theory	9/90 - 1/91
Mestre, Jean-Francoise (France)	Harvard University	Number Theory	9/90 - 1/91
Moriyoshi, Hitoshi (Japan)	SUNY at Buffalo	Topology and Geometry, K-theory	8/90 - 8/91
Reshetikhin, N. (U.S.S.R.)	Harvard University	Quantum Groups	7/90 - 6/93
Serre, J.-P. (France)	Harvard University	Number Theory	9/90 - 12/90
Tan, Weixin (China)	SUNY at Buffalo	Mathematical Physics	8/90 - 8/91
Traczyk, Pawel (Poland)	SUNY at Buffalo	Topology	8/90 - 8/91
Watling, Neil A. (United Kingdom)	SUNY at Buffalo	Operator Algebras	8/90 - 8/91
Zhou, Hao-Xuan (China)	SUNY at Buffalo	Topology	8/90 - 8/91

Reciprocity Agreements

The American Mathematical Society has "reciprocity agreements" with a number of mathematical organizations around the world. A current list appears below.

These Reciprocity Agreements provide for reduced dues for members of these organizations who choose to join the AMS and who reside outside of the U.S. and Canada. Reciprocally, members of the AMS who reside in the U.S. or Canada may join these organizations at a reduced rate. Summaries of the privileges available to AMS members who join under the terms of reciprocity agreements are given on the following pages. Members of these organizations who join the AMS as reciprocity members enjoy all the privileges available to ordinary members of the Society. AMS dues for reciprocity members are \$44 for 1989 and \$46 for 1990. Each organization was asked to review and update its listing in the Spring. An asterisk (*) after the name of an organization indicates that no response to this request had been received when the July/August *Notices* went to press. A disc (•) before the name of an organization indicates that application forms for that organization may be obtained by writing the American Mathematical Society, P.O. Box 6248, Providence, Rhode Island 02940.

Africa

•Nigerian Mathematical Society*

Apply to: Christopher O. Imoru (Secretary), Nigerian Mathematical Society, Department of Mathematics, University of Ife, Ile-Ife, Nigeria.

Dues: \$10; payable to the Treasurer, Nigerian Mathematical Society, Department of Mathematics, University of Benin, Benin City, Nigeria.

Privileges: *Journal of the Nigerian Mathematical Society* at the price normally charged to individual members.

Officers: A. Olubummo (President), J. O. C. Ezeilo (Vice-President), C. O. Nwachuku (Treasurer), C. O. M. Imoru (Secretary), S. A. Ilori (Assistant Secretary), H. O. Tejumola (Editor-in-Chief).

Asia

•Allahabad Mathematical Society*

Apply to: P. Srivastava, Secretary, Allahabad Mathematical Society, 10, C.S.P. Singh Marg, Allahabad-211 001, India.

Dues: US \$20 (annual), US \$150 (life); payable to Allahabad Mathematical Society.

Privileges: Indian Journal of Mathematics.

Officers: Vachaspati (President), V. Kannan, B. S. Yadav (Vice-President), K. K. Azad (Treasurer), P. Srivastava (Secretary).

Calcutta Mathematical Society*

Apply to: U. Basu, Secretary, Calcutta Mathematical Society, 92, Acharya Prafulla Chandra Road, Calcutta 700 009, India.

Dues: \$2; payable to U. Basu, Secretary.

Privileges: *News Bulletin* (free of cost).

Officers: M. Dutta (President), P. C. Vaidya, B. R. Bhonsle, F. Harary, L. Debnath, S. P. Bandyopadhyay, (Vice-Presidents), B. K. Datta, (Treasurer), U. Basu (Secretary).

Indian Mathematical Society

Apply to: S. P. Arya, General Secretary, Indian Mathematical Society, Department of Mathematics, Maitreyi College, Babu Dham Complex, Chanakyapuri, New Delhi 110 021, India.

Dues: \$20; payable to M. K. Singal, Hon. Treasurer, IMS, Department of Mathematics, Meerut University, Meerut-250 005, India.

Privileges: *Mathematics Student*.

Officers: V. M. Shah (President), M. P. Singh (Immediate Past President), M. K. Singal (Treasurer), S. P. Arya (General Secretary), J. N. Kapur (Academic Secretary), I. B. S. Passi (Editor of *Journal of Indian Mathematical*).

Society), A. M. Vaidya (Editor of *Mathematics Student*), K. S. Padmanabhan (Hony. Librarian).

•Korean Mathematical Society*

Apply to: Hyunkoo Lee, 538 Dowha Dong, Mapo Ku, Sung Ji Building, Room 706, Seoul 121-742, Korea.

Dues: \$15; payable to the Korean Mathematical Society.

Privileges: Free receipt of *Bulletin* (two issues per year) and *Journal of the Korean Mathematical Society* (two issues per year).

Officers: Jaihan Yoo (President), Heon Jae Lee (Vice-President), Hong Oh Kim (Treasurer), Hyunkoo Lee (Secretary).

•Malaysian Mathematical Society

Apply to: The Secretary, Malaysian Mathematical Society, c/o Department of Mathematics, University of Malaya, 59100 Kuala Lumpur, Malaysia.

Dues: \$5; payable to Malaysian Mathematical Society.

Privileges: *MMS Newsletter*, *Bulletin of the Malaysian Mathematical Society* (two issues per year), reduced rate for *Menemui Matematik* (three issues per year).

Officers: Sek-Wui Seah (President), Cho-Seng Lee, King-Tak Lee (Vice-Presidents), Seng-Seong Book (Treasurer), Gek-Ling Chia (Hon. Secretary), Ah-Hin Pooi (Ass. Hon. Secretary).

•Mathematical Society of Japan

Apply to: Setsuko Izawa, Secretary, Mathematical Society of Japan, 25-9-203, Hongo 4-chome, Bunkyo-ku, Tokyo 113, Japan.

Dues: US \$40; payable to Mathematical Society of Japan.

Privileges: *Journal of the Mathematical Society of Japan*; *Sugaku* (in Japanese) for US \$8 additional dues.

Officers: Akio Hattori (President), Takuo Isa (Treasurer), Setsuko Izawa (Secretary).

Mathematical Society of the Republic of China*

Apply to: Mathematical Society of the Republic of China, P.O. Box 23-3, Taipei, Taiwan, Republic of China.

Dues: N.T. \$200 (US \$5.00); payable to Mathematical Society of the Republic of China.

Privileges: *Chinese Journal of Mathematics* (two to four issues per year).

Officers: Simon C. Hsieh (President), Jau-D. Chen (Treasurer), Liang-Chi Tsao (Secretary).

•Punjab Mathematical Society

Apply to: M. Rafique, Secretary, Punjab Mathematical Society, Department of Mathematics, University of the Punjab, Quaid-I-Azam Campus, Lahore 54590, Pakistan.

Dues: US \$25 for life membership; payable to Secretary or Treasurer.

Privileges: Mathematics Forum, Proceedings of the Conferences, Symposia, and Seminars arranged by the Society.

Officers: F. D. Anjum Roomani (President), Nawazish Ali Shah, M. Sadig Zia (Vice-Presidents), Khalifa Rashid-ud-Din (Treasurer), M. Rafique (Secretary).

•Ramanujan Mathematical Society

Apply to: E. Sampathkumar, Secretary, Ramanujan Mathematical Society, Department of Mathematics, Manasagangotri, Mysore University, Mysore-570006, India.

Dues: \$15 (annual), \$150 (life); payable to Secretary, Ramanujan Mathematical Society.

Privileges: *Journal of Ramanujan Mathematical Society*.

Officers: C. S. Seshadri, F.R.S. (President), J. Gopalakrishna (Vice-President), N. Ranganathan (Treasurer), E. Sampathkumar (Secretary).

•Southeast Asian Mathematical Society

Apply to: Southeast Asian Mathematical Society, c/o Department of Mathematics, Chinese University of Hong Kong, Shatin, N.T., Hong Kong.

Dues: US \$5; payable to Southeast Asian Mathematical Society.

Privileges: *SEAMS Newsletter*, *Southeast Asian Bulletin of Mathematics*.

Officers: K. P. Shum (President), Y. Lan (Treasurer), P. C. Yuen (Secretary).

•Vijnana Parishad of India

Apply to: H. M. Srivastava, Foreign Secretary, VPI, Department of Mathematics, University of Victoria, Victoria, British Columbia, Canada, V8W 2Y2 or R. C. Singh Chandel, Secretary, VPI, Department of Mathematics, D. V. Postgraduate College, Orai-285001, U. P., India.

Dues: US \$12 (annual), US \$120 (life); payable to Vijnana Parishad, c/o Department of Mathematics, D. V. Postgraduate College, Orai-285001, U. P., India.

Privileges: *Jñānabha* (an interdisciplinary mathematical journal currently published once a year); back volumes available at 25% discount.

Officers: J. N. Kapur (President), R. P. Agarwal, M. K. Singal, J. N. Pathak (Vice-Presidents), R. C. Singh Chandel (Secretary-Treasurer), H. M. Srivastava (Foreign Secretary).

Europe

Asociación Matemática Española*

Apply to: Miguel de Guzmán, President, Asociación Matemática Española, Facultad de Matemáticas, Universidad Complutense, Madrid 3, Spain.

Dues: US \$15 for members of the American Mathematical Society; payable to Asociación Matemática Española.

Privileges: *Boletín de la Asociación Matemática Española*; *Publicaciones de la Asociación Matemática Española* (at reduced prices).

Officers: Miguel de Guzmán, (President), Ireneo Peral (Treasurer), Maria T. Carrillo (Secretary).

•Berliner Mathematische Gesellschaft e.V.

Apply to: R. D. Grigorieff, Fachbereich Mathematik, TU Berlin, Straße des 17. Juni 136, D-1000 Berlin 12, Federal Republic of Germany.

Dues: DM 12; payable to G. Preuss, Institut für Mathematik I, FU Berlin, Arnimallee 3, D-1000 Berlin 33, Federal Republic of Germany.

Privileges: One free copy of "Sitzungsberichte der BMG".

Officers: E.-J. Thiele (President), H.G.W. Begehr (Vice-President), G. Preuss (Treasurer), R. D. Grigorieff (Secretary).

•Dansk Matematisk Forening

Apply to: Mogens Esrom Larsen, Secretary, Dansk Matematisk Forening, Universitetsparken 5, 2100 København Ø, Denmark.

Dues: D.kr. 50; payable to Erik Christensen, Treasurer.

Privileges: *Mathematica Scandinavica* (D.kr. 183 per volume), *Nord. Mat. Tidss. (Normat)* (N.kr. 130 per volume). (Members of the American Mathematical Society do not have to join Dansk Matematisk Forening to obtain the journals. Subscription orders should be sent directly to the journals: *Normat*, Universitetsforlaget, Avd. for tidsskrifter, Postbox 2959 Tøyen, Oslo 6, Norway; *Mathematica Scandinavica*, Matematisk Institut, Aarhus Universitet, 8000 Aarhus C, Denmark.)

Officers: Kjeld Bagger Laursen (President), Mogens Esrom Larsen (Vice-President), Erik Christensen (Treasurer), Mogens Esrom Larsen (Secretary), Ebbe Thue Poulsen, Sten Markvorsen.

•Deutsche Mathematiker-Vereinigung e.V.*

Apply to: Deutsche Mathematiker-Vereinigung e.V., Albertstraße 24, 7800 Freiburg, Federal Republic of Germany.

Dues: DM 30.- (for reciprocity members); payable to Kreissparkasse Tübingen 16269 (BLZ 641 500 20), Federal Republic of Germany or Postscheckamt Stuttgart 18517-706 (BLZ 600 100 70), Federal Republic of Germany.

Privileges: *Mitteilungen der Deutschen Mathematiker-Vereinigung* (four issues a year), *Jahresbericht der Deutschen Mathematiker-Vereinigung* (four issues a year).

Officers: W. Törnig (President), K. P. Grotemeyer (Treasurer), J. Flum (Secretary).

•Edinburgh Mathematical Society

Apply to: The Honorary Secretary, Edinburgh Mathematical Society, James Clerk Maxwell Building, King's Buildings, Mayfield Road, Edinburgh, EH9 3JZ, Scotland.

Dues: \$8 (preferably £3 sterling); payable to the Honorary Secretary.

Privileges: *Proceedings* at reduced rate of \$15 (preferably £6 sterling) per annum.

Officers: J. M. Ball (President), E. G. Rees (Vice-President), A. D. Sands (Treasurer), J. Martin, C. J. Shaddock (Secretaries).

•Gesellschaft für Angewandte Mathematik und Mechanik (GAMM)

Address for mail: Reinhard Mennicken, University of Regensburg, D-8400 Regensburg, Federal Republic of Germany.

Apply to: R. Ansorge, Institut für Angewandte Mathematik, Universität, Hamburg, Bundesstr. 55, D-2000 Hamburg 13, Federal Republic of Germany.

Dues: 25.-DM; payable to J. Siekmann, FB 12 - Maschinentechnik, Universität - GHS Essen, Schützenbahn 70, D-4300 Essen, Federal Republic of Germany.

Privileges: Regular publications of GAMM and participation in scientific meetings at a reduced rate.

Officers: O. Mahrenholtz (President), W. Walter (Vice-President), J. Siekmann (Treasurer), R. Mennicken (Secretary), R. Ansorge (Vice-Secretary).

•Glasgow Mathematical Association

Apply to: K. A. Lindsay, Glasgow Mathematical Association, Department of Mathematics, University of Glasgow, University Gardens, Glasgow G12 8QW, Scotland.

Dues: £20.50; payable to Glasgow Mathematical Association.

Privileges: *Glasgow Mathematical Journal*.

Officers: R. Bailie (President), S. G. Hoggar (Vice-President), K. A. Lindsay (Treasurer), S. J. Rowan (Secretary).

•Irish Mathematical Society

Address for mail: G. Ellis, Secretary, Mathematics Department, University College, Galway, Ireland.

Apply to: D. Tipple, IMS Treasurer, Department of Mathematics, University College, Dublin 4, Ireland.

Dues: US \$10; payable to D. Tipple.

Privileges: Right to receive the *Bulletin of the Irish Mathematical Society*; right to subscribe to the *Proceedings of the Royal Irish Academy* (Section A) at a reduced rate.

Officers: F. Gaines (President), R. M. Timoney (Vice-President), D. Tipple (Treasurer), G. Ellis (Secretary).

Íslenzka Stærðfræðafélagið*

Apply to: President, Raunvísindastofnun Háskólans, Dunhaga 3, 107 Reykjavik, Iceland.

Dues: \$10; payable to Íslenzka Stærðfræðafélagið.

Privileges: Newsletter (yearly).

Officers: Halldór I. Eliasson (President), Kristian Jónasson (Treasurer), Ragnar Sigurdsson (Secretary).

•János Bolyai Mathematical Society

Apply to: Secretary General, J. Bolyai Mathematical Society, Anker Köz 1--3, Budapest, Hungary H-1061.

Dues: Are voluntary but should minimally cover duplication and mailing costs; Reciprocity members (residing outside Hungary) suggested fee is 1/8 of one percent of the member's net income; sponsoring members pay at least US \$180 or equivalent per year.

Privileges: Upon request—Matematikai Lapok (twice a year), Középiskolai Matematikai Lapok (monthly), and Matematikai Tanítás (bimonthly). If sufficient interest

is expressed, a Bulletin in English will be available. In addition, the JBMS is negotiating to obtain discounts for its reciprocity and sponsoring members on several serial publications and periodicals appearing in Hungary. Contact the JBMS secretary for more information regarding this and other privileges of membership.

Officers: András Hajnal (President), Gyula Katona (Secretary General), Cecilia Szabados (Vice-Secretary General), András Recski (Treasurer).

•London Mathematical Society

Apply to: Miss S.M. Oakes, London Mathematical Society, Burlington House, Piccadilly, London W1V 0NL, United Kingdom.

Dues: £5; payable to London Mathematical Society. (New members should not send payment until elected.)

Privileges: *LMS Newsletter*. Reduced rates for the *Bulletin*, *Journal*, and *Proceedings of the LMS*; *Nonlinearity*; *Journal of Applied Probability*; *Mathematika*; *Mathematical Proceedings of the Cambridge Philosophical Society*; *Quarterly Journal of Mathematics*; LMS Lecture Notes; LMS Student Texts; LMS Monographs. (Please write to the LMS for complete details.)

Officers: J. H. Coates (President), E. C. Lance, R. L. E. Schwarzeberger (Vice-Presidents), J.D.M. Wright (Treasurer), R. Y. Sharp, A. R. Pears (Secretaries), D. A. Brannan (Publications Secretary).

•Norsk Matematisk Forening

Apply to: Gerd Salter, Norsk Matematisk Forening, Matematisk Institutt, Postboks 1053 Blindern, N-0316 Oslo 3, Norway.

Dues: N.kr. 50 or N.kr. 500 for permanent membership; payable to Gerd Salter, Norsk Matematisk Forening.

Privileges: Reduced subscription rate on *Mathematica Scandinavica* and *NORMAT* (*Nordisk Matematisk Tidsskrift*), free monthly information bulletin "infomat" about the activities of the Society.

Officers: Ragni Piene (President), Tom Lindström (Vice-President), Bjørn Jahren (Treasurer), Jon Reed (Secretary).

•Österreichische Mathematische Gesellschaft

Apply to: Ludwig Reich, President, Österreichische Mathematische Gesellschaft, Technische Universität Wien, Wiedner Hauptstraße 8-10, A-1040 Wien, Austria.

Dues: S 150; payable to Inge Troch, Treasurer.

Privileges: *Internationale Mathematische Nachrichten* (IMN).

Officers: Ludwig Reich (President), Werner Kuich (Vice-President), Inge Troch (Treasurer), Hans Reichel (Secretary).

Polskie Towarzystwo Matematyczne*

Apply to: Polskie Towarzystwo Matematyczne, Śniadeckich 8, 00-950 Warszawa, Poland.

Dues: \$8; payable to Polskie Towarzystwo Matematyczne.

Privileges: Participation in scientific conferences organized by the Polish Mathematical Society and in its scientific sessions; in addition, members receive one of the following five series of the publication *Annales Societatis Mathematicae Polonae: Commentationes Mathematicae* in congress languages, *Wiadomości Matematyczne* (Mathematical News) in Polish, *Matematyka Stosowana* (Applied Mathematics) in Polish, *Fundamenta Informaticae* in congress languages, *Dydaktyka Matematyki* (Didactics of Mathematics) in Polish.

Officers: Andrzej Pelczar (President), Roman Duda, Adam Piskorek (Vice-Presidents), Maciej Bryński (Secretary), Janusz Kowalski (Vice Secretary), Maciej Mączyński (Treasurer).

Real Sociedad Matemática Española

Apply to: J. Llovet, Secretario General de la Real Sociedad Matemática Española, Dept. Matemáticas, Universidad Alcala, 28871 Alcala Henares (Madrid) Spain.

Dues: \$30; payable to Secretario, R. S. M. E.

Privileges: *Gaceta Matemática* and *Revista Matemática Ibero Americana*.

Officers: J. M. Aroca (President), Juan Llovet Verdugo (Secretary).

Sociedade Portuguesa de Matemática

Apply to: J. E. Valença, Sociedade Portuguesa de Matemática, Av. da República 37 4º, 1000 Lisboa, Portugal.

Dues: 600 Portuguesa Escudos; payable to Sociedade Portuguesa de Matemática.

Privileges: *Boletim da Sociedade Portuguesa de Matemática*, free; discount of 70% in the subscription fees for *Portugaliae Mathematica*.

Officers: A. Ribeiro Gomes (President), J. E. Valença, J. C. Silva, J. F. Queiró (Vice-Presidents), A. M. Cadete (Treasurer).

Societat Catalana de Matemàtiques*

Apply to: Secretari de la Societat Catalana de Matemàtiques, Carrer del Carme 47, 08001 Barcelona, Spain.

Dues: 1000 pessetes for members of the AMS, payable to the Societat Catalana de Matemàtiques.

Privileges: *Butlletí de la Societat Catalana de Matemàtiques*, (2 numbers a year).

Officers: J. Girbau (President), Carles Perelló (Secretary), Rubi Corberó (Associated Secretary).

Société Mathématique de Belgique*

Apply to: Guy Hirsch, Secretary, Société Mathématique de Belgique, 317/11, Avenue Charles Woeste, 1090 Brussels, Belgium.

Dues: \$25; payable to Société Mathématique de Belgique, preferably by International Money Order, VISA, MasterCard, or American Express.

Privileges: *Bulletin de la Société Mathématique de Belgique* (6 numbers per year in 1989 and 1990). Series A and Series B, totalling about 800 pages.

Officers: A. Verschoren (President), L. Lemaire (Vice-President), G. Hirsch (Secretary-Treasurer).

Société Mathématique de France

Address for mail: Société Mathématique de France, B.P. 126-05, F 75226 Paris, Cedex 05, France.

Apply to: Madame Janine Le Peintre, S.M.F., B.P. 126-05, F 75226 Paris, Cedex 05, France.

Dues: \$36; payable to American Mathematical Society or S.M.F.

Privileges: Individuals who pay dues of \$33 are entitled to receive the *Gazette*. Other publications may be purchased at the following prices: *Officiel* (surface mail) \$17, *Officiel* (air mail) \$25, *Bulletin* (without *Mémoires*) \$33, *Bulletin & Mémoires* \$53. *Astérique* may be purchased at a discount price. (Members in the U.S., Canada, or Mexico should order their copies from the AMS. See the AMS *Catalogue of Publications*.)

Officers: G. Schiffmann (President), J. Detraz, J. M. Lemaire, J. Stern (Vice-Presidents), A. Millet (Treasurer), M. Chaleyat-Maurel, B. Helffer (Secretaries).

•Société Mathématique Suisse

Apply to: F. Sigrist, Secretary SMS, Institut de Mathématiques, Chantemerle 20, CH-2007 Neuchâtel, Switzerland.

Dues: SFr. 15.- for members of the AMS residing outside Switzerland; payable to F. Sigrist.

Privileges: *Commentarii Mathematici Helvetici* (reduced price); information concerning activities of SMS.

Officers: U. Stambach (President); H. Holmann (Vice-President); F. Sigrist (Treasurer-Secretary).

•Société de Mathématiques Appliquées et Industrielles*

Apply to: Société de Mathématiques Appliquées et Industrielles, Centre de Mathématiques Appliquées, École Polytechnique, 91128 Palaiseau, France.

Dues: US \$25; Société de Mathématiques Appliquées et Industrielles.

Privileges: Free subscription to the *News Bulletin*, reduced rates at conferences organized by SMAI.

Officers: J. C. Nedelec (President), P. Lascaux, J. Periaux (Vice-Presidents), M. Lenoir (Treasurer), G. Meurant (Secretary).

•Suomen Matemaattinen Yhdistys

Apply to: Heikki Heikkilä, Secretary, Department of Mathematics, University of Helsinki, Hallituskatu 15, SF-00100 Helsinki, Finland.

Dues: 75 FIM; payable to Aatos Lahtinen, Treasurer, Department of Mathematics, University of Helsinki, Hallituskatu 15, SF-00100 Helsinki, Finland.

Privileges: *Arkhimedes* (four issues a year) and *Eukleides* (newsletter).

Officers: Seppo Rickman (President), Olli Martio (Vice-President), Aatos Lahtinen (Treasurer), Heikki Heikkilä (Secretary).

•Svenska Matematikersamfundet

Apply to: Torbjörn Tambour, Svenska Matematikersamfundet, Department of Mathematics, University of Lund, Box 118, S-22100 Lund, Sweden.

Dues: 40 Skr. or 1000 Skr. for permanent membership; payable to Svenska Matematikersamfundet, Ingegerd Palmér, Dept. of Mathematics, KTH, S-10066, Stockholm, Sweden.

Privileges: *Mathematica Scandinavica* and *Nordisk Matematisk Tidskrift* at reduced rate. Information about the meetings of the Society.

Officers: Gert Almkvist (President), Peter Sjögren (Vice-President), Ingegerd Palmér (Treasurer), Torbjörn Tambour (Secretary).

•Unione Matematica Italiana

Apply to: Segreteria della Unione Matematica Italiana, Dipartimento di Matematica, Piazza Porta S. Donato, 5, 40127 Bologna, Italy.

Dues: 40,000 lire; payable to Unione Matematica Italiana.

Privileges: Free *Notiziario dell'UMI* (monthly), *Bollettino dell'UMI, ser. A* (3 issues a year), and membership list. Reduced fees for subscriptions to *Bollettino dell'UMI, Ser. B.* and discounts for other UMI publications.

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Wiskundig Genootschap*

Address for mail: Wiskundig Genootschap, Delft University of Technology, Department of Mathematics and Informatics, P.O. Box 356, 2600 AJ Delft, The Netherlands.

Apply to: Membership Department, Wiskundig Genootschap, University of Utrecht, Postbus 80010, 3508 TA Utrecht, The Netherlands.

Dues: Hfl 40.-; payable to Amro Bank, Utrecht, The Netherlands, Account 45.65.88.167, Penningmeester Wiskundig Genootschap.

Privileges: *Nieuw Archief Voor Wiskunde* (three issues a year containing articles and a problem section), *Mededelingen* (nine issues a year containing announcements and book reviews), *Proceedings of the Royal Academy of Sciences* - "Indagationes Mathematicae" (can be obtained at a reduced subscription rate of Hfl 120.-).

Officers: J. P. Murre (President), G. Y. Nieuwland (Vice-President), J. Stegeman (Treasurer), R. W. Goldbach (Secretary).

Latin America

•Sociedad Colombiana de Matemáticas*

Apply to: Sociedad Colombiana de Matemáticas, Apartado Aéreo 2521, Bogotá, D.E., Colombia.

Dues: \$16; payable to Sociedad Colombiana de Matemáticas.

Privileges: Either *Revista Colombiana de Matemáticas* (four issues a year) or *Lecturas Matemáticas* (three issues a year).

Officers: Myriam Muñoz de Özak (President), Luis Jorge Ferro (Vice-President), Luis Giraldo (Treasurer), Oswaldo Lezama (Secretary).

Sociedad de Matemática de Chile

Apply to: Secretario, Sociedad de Matemática de Chile, Casilla 653. Santiago, Chile.

Dues: US \$10; payable to Sociedad de Matemática de Chile.

Privileges: Receive: *Gaceta de la Sociedad, Notas de la Sociedad de Matemática de Chile* (two issues per year).

Officers: Gonzalo Riera (President), Victor H. Cortes (Vice-President), Renato Lewin (Treasurer), Irene Mikenberg (Secretary).

Sociedad Matemática de la República Dominicana

Apply to: Eduardo Luna, Sociedad Matemática de la República Dominicana, P. O. Box 797-2, Santo Domingo, Dominican Republic.

Dues: US \$6; payable to Isidro Rodríguez, Sociedad Matemática de la República Dominicana.

Privileges: Right to receive *Notimat* (bimonthly newsletter) and *Revista Matemática Dominicana* (twice a year).

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Sociedad Matemática Mexicana*

Apply to: Sra. Hilda C. de Villa, Apartado Postal 70-450, Mexico 20, D.F. Mexico 04510.

Dues: US \$10; payable to Sociedad Matemática Mexicana.

Privileges: To be a regular member paying half of the regular fee for persons living outside of Mexico.

Officers: Alejandro Lopez-Yanez (President), Diego B. Hernandez (Vice-President), Juan Morales (Treasurer), Luis Rivera-Gutierrez (Secretary).

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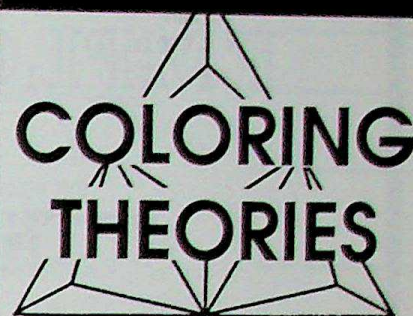
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(Contemporary Mathematics,
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1980 *Mathematics Subject Classification*: 05

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August 8 - 11, 1990

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The Mathematical Sciences Employment Register would like to make employers and applicants aware of the job placement services that will be provided at the Joint Mathematics Meetings in Columbus, Ohio, August 8 - 11, 1990.

Unlike the Employment Register during the Winter Joint Mathematics Meetings, the summer job placement services **do not involve scheduled interviews**. Instead, there will be a central location at the Columbus Meetings where applicants may post their résumés and employers may list job openings. It is then up to employers and applicants to schedule their own interviews. Individuals can contact each other using the Message Center provided at the Meetings.

In addition, a Summer List of Applicants, containing résumés of mathematical scientists seeking employment, will be published and available at the Meetings.

More information on the employment services available at the Columbus Meetings may be found in the program for the Meetings, in the April 1990 issue of *Notices*, pages 459 - 460.

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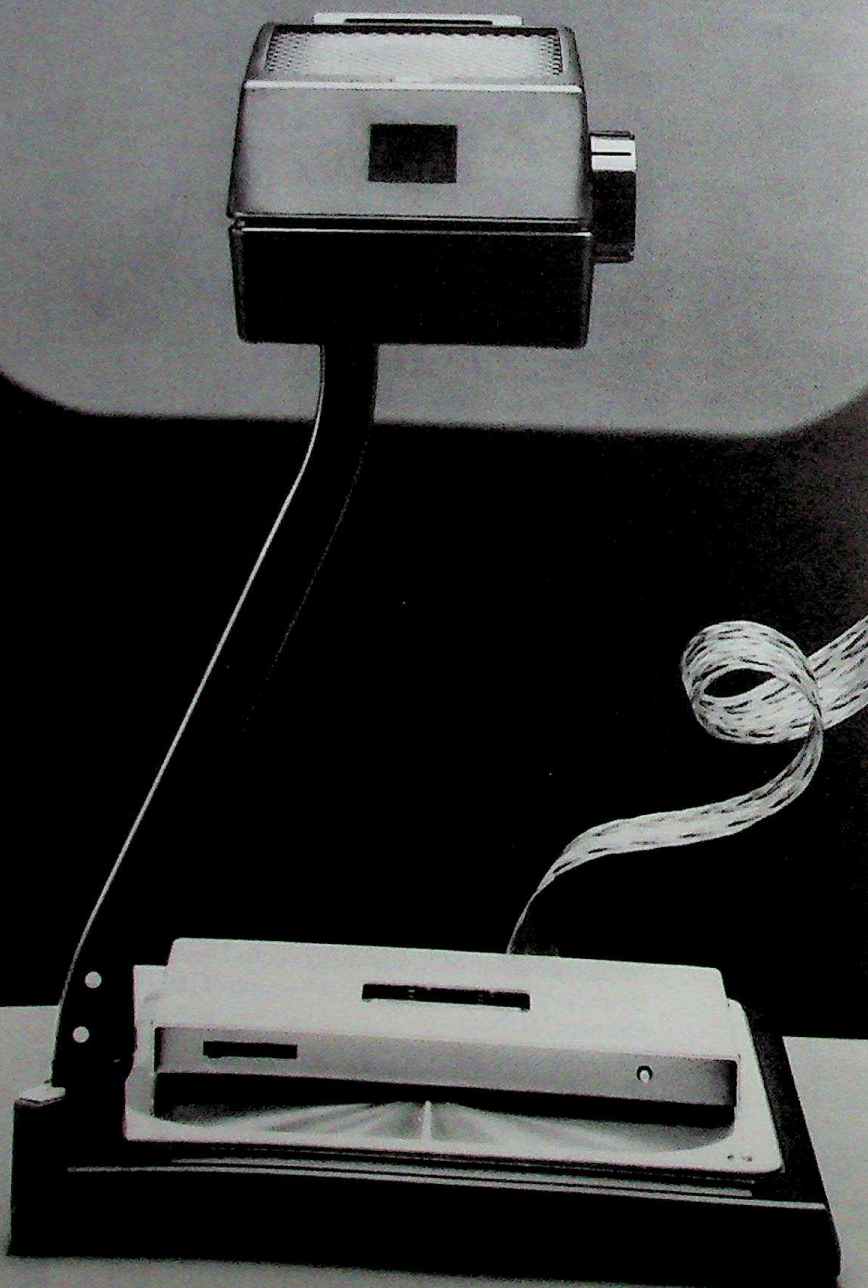
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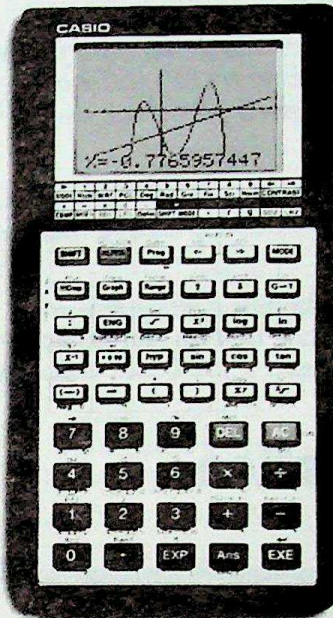
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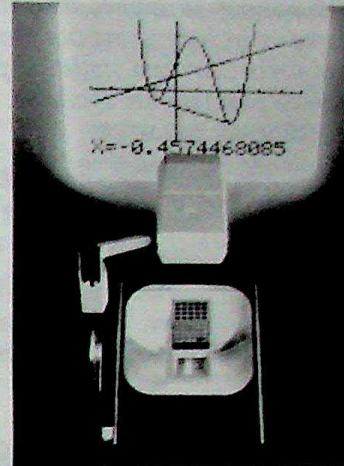
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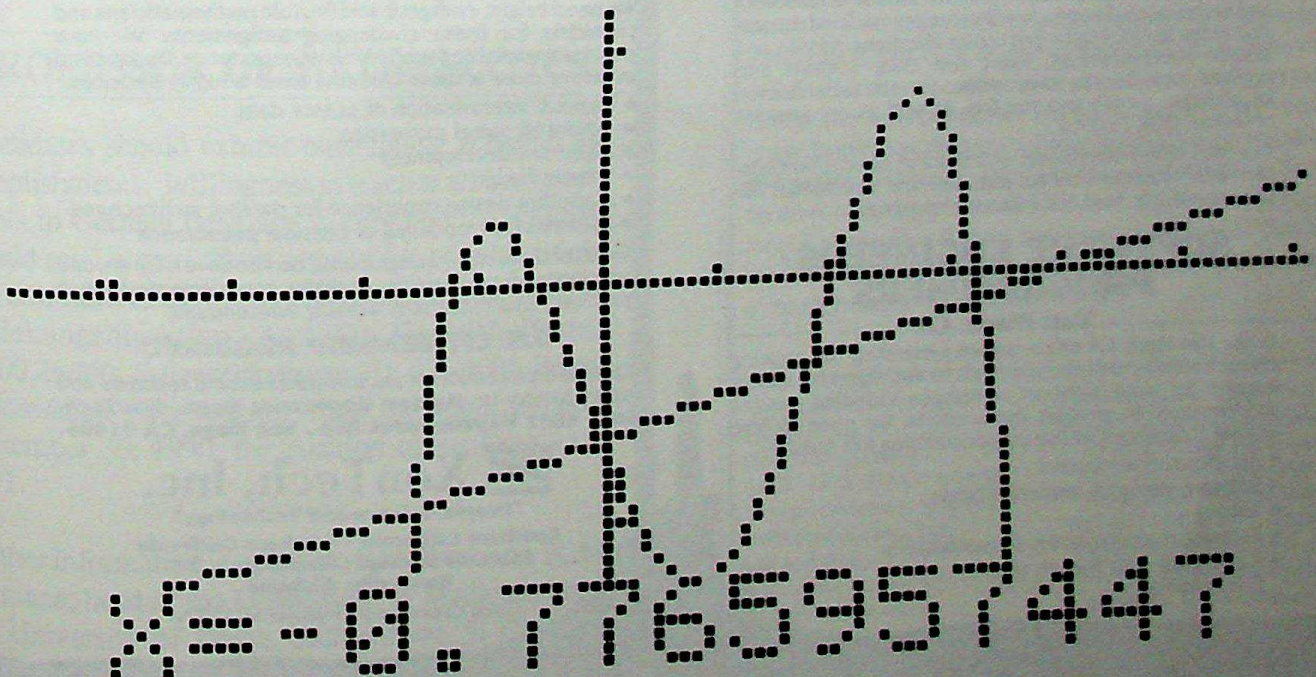
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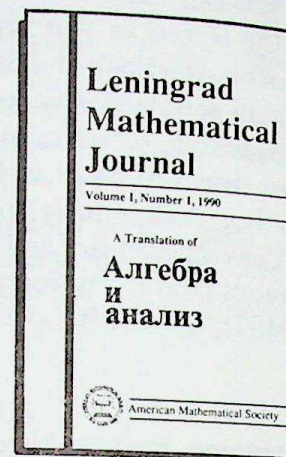
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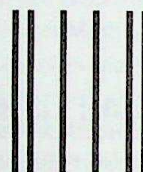
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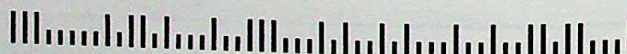
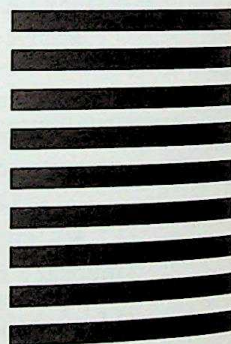
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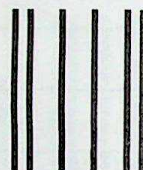
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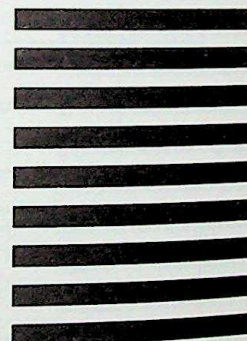
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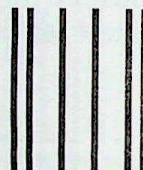
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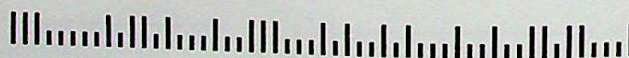
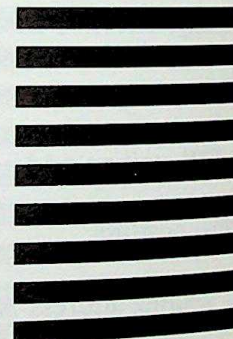
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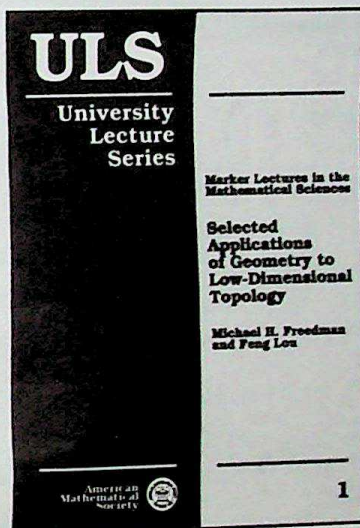
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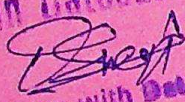
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